ELEMENTS

OF

HUMAN ANATOMY.

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HUMAN ANATOMY:

GENERAL, DESCRIPTIVE, AND PRACTICAL.

BY

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SECOND EDITION.

Carefully Revised and Illustrated by nearly Three Hundred Engravings.

"What a piece of work is a man! How noble in reason! how infinite in faculties! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals."

PHILADELPHIA:
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PREFACE

TO THE

SECOND EDITION.

When the first edition of this work was written, the author was comparatively fresh from his pupilage, and therefore fully apprised of the wants and difficulties of those for whom he wrote. His subsequent experience as a public teacher of anatomy, and his familiar intercourse with students in the dissecting-room, have confirmed him in the opinion, that the arrangement of the subject here adopted is far preferable, in an elementary treatise, to the systematic plan necessarily pursued in works of a more extended character. Following, therefore, the original outline, he has attempted in the present edition not only to improve the descriptions, but to give them that degree of completeness and fullness required in a "text-book," without marring its usefulness as a "dissector."

Many changes have also been made in the illustrations, new ones having been substituted where this seemed desirable, and numerous others, not found in American works, added to the list. For the former the author has drawn largely upon Leidy's

Human Anatomy, and for the latter he is mainly indebted to the excellent "Manual of Anatomy," by Luther Holden, F.R.C.S., of London.

The author also takes this opportunity of making his profound acknowledgments to Dr. Richard J. Dunglison, of Philadelphia, for his great kindness and attention in supervising the publication, and for numerous valuable suggestions made during the progress of the work.

UNIVERSITY OF LOUISIANA, MEDICAL DEPARTMENT,
New Orleans, May, 1867.

PREFACE

TO THE

FIRST EDITION.

In adding another to the numerous list of books on anatomy already before the profession, the author claims no credit beyond that of a common observer, whose experience, in the dissecting-room and amphitheatre, has suggested what he believes to be a slight improvement on the plan pursued by the majority of writers on this branch of physico-medical science. This improvement consists, in the first place, in the union of general, descriptive, and practical anatomy in the same volume; the intention being to render it unnecessary, on the part of the student just entering upon the study, to provide himself with separate books on these different branches; secondly, in the arrangement of the section devoted to practical anatomy so as to secure the greatest possible economy of material; and lastly, in the substitution of English for Latin terms, wherever this appeared to be practicable and judicious.

To the casual critic these may not seem sufficient reasons for obtruding one's self upon the public; but if the experience of teachers and students of medicine accord with that of the

author, an elementary book arranged upon some such plan has long been a desideratum; and if the present effort to supply that want prove successful, the author's highest hopes will be realized.

In regard to the matter of the work, it is almost needless to state that the modern writer on anatomy has very little that is new to say, except in the microscopical and chemical department; but the numberless alleged discoveries and theories relating to these divisions of anatomy could not, with propriety or advantage, be introduced into a treatise so elementary as this. In special anatomy, all the principal facts were long ago discovered and published, and even the descriptions themselves have been so carefully expressed by successive writers, that, like the established formulæ of mathematics, they do not often admit of change without prejudice to their clearness and precision.

University of Louisville, Medical Department,
October, 1853.

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INTRODUCTION.

Anatomy, in its most comprehensive signification, is the science of organization. Its object is to investigate the material structure of the living creation. There is, therefore, an anatomy of vegetables as well as of animals.

When anatomy investigates the whole series of animals, and compares the same organs as found in different species and in man, it is called *zoological* or *comparative anatomy*.

Special anatomy is confined to a single species, as for instance *human anatomy*, the special subject of this treatise; but more frequently special anatomy is employed in the sense of descriptive anatomy. If it considers the organs in their healthy state, it is called *physiological anatomy;* if it describes their diseased condition, it is *pathological anatomy.*

Physiological anatomy may be either *descriptive*, having reference only to the outward characters and mutual relations of the different organs of the body, or it may be *general* (*histology*), and then examines the interior of the organs, and determines their minute texture and composition.

Practical anatomy, or the art of dissection, may be pursued with reference to any of these divisions, or it may have par-

ticular regard to surgery. For the latter purpose, the body is mapped off, as it were, into regions, and the several organs found in these regions are considered only in their relations to each other. This is termed *surgical* or *topographical anatomy*.

The present treatise is intended to be a brief outline of general and descriptive anatomy, arranged to serve both as a text-book and dissector's guide.

PART I.

GENERAL ANATOMY

OR

HISTOLOGY.

GENERAL ANATOMY.

THE simplest general idea of the anatomy of man is, that the human body consists of a collection of various solid, semifluid, fluid, and gaseous substances, held in intimate relation by physical and vital forces, all mutually dependent, and formed into separate parts or organs, which are arranged in groups for the performance of the great functions of the animal economy. To ascertain the situation, relations, and external characters of these organs, and their general disposition in the entire body, was, until recently, the object and limit of anatomical study. Before the time of Bichat,* no successful effort had been made toward a correct analysis of the body into certain distinct "textures" or "tissues," which are recognized by the unaided senses, and distributed throughout the different parts and organs. This illustrious Frenchman indicated, and followed as far as his means of study and his too short life permitted, this new direction of scientific anatomy. He instituted, in fact, the study of general anatomy, which, at the present day, by means of chemistry and the microscope, is making rapid progress toward the perfection already reached by descriptive anatomy. Bichat and his immediate followers, however, admitted as separate tissues only the solid parts of the body, which, in reference to their distribution, he arranged into classes or "systems," such as the "muscular system," "nervous system," etc. But modern anatomists have most clearly demonstrated that many of the fluids justly deserve a similar distinction.

The number of the solid tissues has been variously estimated at from seven to twenty. The following table, in which only fifteen are enumerated, will be found, however, to answer all ordinary purposes. The old, and easily remembered classification, into "general" and "partial" tissues, *i.e.* tissues that are found in every part of the body, and those that exist only in certain localities, is here adopted:

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* MARIE FRANÇOIS XAVIER BICHAT, a distinguished French anatomist and physiologist; died at Paris, A.D. 1802, æt. 31.

GENERAL TISSUES	1. Areolar or connective tissue. 2. Vascular tissue, comprising bloodvessels, lymphatics, and lacteals. 3. Nervous tissue.
PARTIAL TISSUES	4. Epithelial tissue. 5. Pigmentary tissue. 6. Adipose tissue. 7. Muscular tissue. 8. Fibrous tissue. 9. Yellow elastic tissue. 10. Cartilaginous tissue, including fibro-cartilage. 11. Osseous tissue. 12. Cutaneous tissue. 13. Mucous membrane. 14. Serous membrane. 15. Glandular tissue.

These fifteen tissues constitute the entire organism of the body, with the exception of the enamel of the teeth, spleen, crystalline lens, thyroid body, and one or two other organs, which are probably distinct, but, on account of their very limited distribution, are not usually included in the list of individual tissues.

The beginner must not, however, for a moment suppose that these several tissues are ultimate elementary structures. Some of them, indeed, as the vascular, are composed of several tissues, and deserve to be called "organs" rather than tissues; and all are susceptible of being resolved into more minute parts or elements. This ultimate analysis of the tissues, by means of the microscope, into their true "anatomical elements," constitutes the great advance made in the study of organized substances within the last twenty years, and establishes a foundation for general anatomy almost entirely unknown to Bichat.

The anatomical or constituent elements (called also microscopic elements, because they can be seen only with the microscope) are few and simple, and must be carefully distinguished from the tissues which they form, and the fluids in which they are suspended. They are:

1. Minute particles, termed **granules** or **molecules**. These are found suspended in greater or less quantities in nearly all the fluids of the body; but they differ in their chemical nature, and in the changes to which they are subject in the different fluids in which they exist.

2. **Cells**, which have usually a spherical outline, and consist (*a*) of an exceedingly delicate structureless envelope called the "cell-wall"; (*b*) a contained fluid or semifluid substance, generally transparent, but in some situations more or less colored; (*c*) a minute but well-defined, dark granular body suspended in the fluid or attached to the inner surface of the cell-wall, called the "nucleus;" and (*d*) a still more diminutive body, a mere speck as it were, in the midst of the latter, denominated the "nucleolus."

The importance of these little vesicles to the physiologist and anatomist cannot be overestimated. They are, indeed, highly vitalized organs, from or by which all the tissues of the body are developed, and in some instances, as in epithelium, they alone compose the entire structure of a tissue.

3. **Fibres**, either solid or tubular, which enter into the composition of nearly all the tissues, but differ very materially in their size, form, and arrangement in different situations. Some of the tissues, such as the muscular, areolar, etc., consist exclusively of fibres.

4. **Structureless or amorphous material**, so called because it seems to possess no definite texture and is perfectly transparent, exists both as solid and fluid, and constitutes the basis of several of the special tissues. It is particularly abundant in cartilage, where in conjunction with peculiar cells it composes the entire structure.

The fluids of the body, aside from the fact that they constitute the larger proportion of the weight of the entire mass,* are, as already mentioned, quite as interesting to the student of general anatomy and physiology as the structures to which the term tissue is commonly limited; and the same may also be said of the gases (oxygen, hydrogen, nitrogen, carbonic acid, etc.) found dissolved in some of the fluids. But with the exception of the blood, chyle, and lymph, none of these will be noticed here.

Physical and Vital Properties of the Tissues.—The general physical properties, such as consistence, color, weight, and elasticity, belong, of course, to the animal tissues. During life, these properties are more or less modified by the great governing vital forces, and the facts ascertained concerning them by experiments upon dead structures cannot, therefore, be implicitly relied upon. In fact, many of the properties exhibited after death are wholly incompatible with life, as, for instance, the coagulation of the blood; while, on the other hand, a still greater number are directly concerned in maintaining this condition. The more important will be mentioned in connection with the description of the separate tissues.

The **vital properties** are those peculiar endowments derived from or dependent upon the great principle of life which pervades all organized structures, enabling them to resist the decomposing influences by which they are surrounded, and to perform certain general and specific

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* The relative proportion between the fluid and solid parts of the body, although by no means constant, varying greatly in different individuals and in the same individual under different circumstances, is usually stated at 4 or 5 parts of the former to 1 of the latter. These figures, however, can be only approximately true, since they are obtained by weighing a dead body before and after it has been subjected to thorough desiccation in an oven; an experiment in which not only the fluids are dried off, but some of the solid matters also decomposed and dissipated.

functions. Of these the more widely distributed in the animal economy are: 1. The nutritive or assimilative force or property which manifests itself in the growth and continual reproduction of the organized material. 2. The motor property, which belongs especially to muscular tissue. 3. The sensitive property, by which we become conscious of impressions made upon different parts of the body, and which resides exclusively in the nervous system. 4. The secretive property, by which certain substances are produced from the blood different from this fluid or from any of its anatomical constituents. Thus bile is secreted by the liver, urine by the kidneys, etc.

Of the **chemical properties** of the tissues, it is only necessary to state here that not less than seventeen elementary substances are known to exist in the human body. They are, oxygen, hydrogen, carbon, nitrogen, phosphorus, sulphur, chlorine, fluorine, potassium, sodium, calcium, magnesium, iron, silicon, manganese, aluminum, and copper. Of these, the four or five first named are far more abundant than all the others; but for an account of their various combinations, the relations which they bear to each other, and the peculiar influence exerted upon them by the vital forces, the student is referred to works on physiology and organic chemistry.

DEVELOPMENT OF THE TISSUES.

Although belonging strictly to the province of physiology, the study of the origin and growth of the tissues is so closely connected with that of their anatomical characters, that some general knowledge of the former is almost essential to a proper understanding of the latter. A mere outline, however, of these processes is all that can be presented here.

It may surprise the young student, but it is nevertheless true, that the human body, with all its apparent complexity of organs and tissues, has its origin in a minute cell or sac, readily seen by means of the microscope, and so nearly resembling that from which some of the inferior animals originate, that it is often impossible to distinguish them from one another. Retracing, therefore, the steps by which the perfect body has arrived at its matured state, we find this primordial cell in the ovary of the female. Here it presents itself as a small spherical body, consisting of a delicate homogeneous membrane, which incloses a drop of fluid and an exceedingly minute, dark body, called the *nucleus* or germinal spot. From this cell or vesicle, with its fluid and nucleus, the entire animal body is developed; but, in order to form a clear idea of the manner in which this takes place, it may be well first to take a cursory view of the analogous but simpler process observed in plants. It was, in fact, by the discovery of cell-growth in vegetables, that physiologists were led to suspect a similar development in animals.

If a drop of the juice found in the fruit of the common snow-berry or

honeysuckle be examined with a microscope of medium power, it will be seen to consist of a collection of small polyhedral or spherical cells, surrounded by a transparent fluid. Each cell is composed of a thin homogeneous capsule, which contains a colored or colorless fluid, and one or more dark granular bodies attached to its inner surface. The surrounding fluid, called the *blastema*, is very similar to that inclosed by the cell; and there may be observed floating in it numerous little granules or corpuscles, precisely like those upon the inside of the cells. Now, previous to the formation of the cells, there exist, as was demonstrated by Schleiden, only the fluid or blastema, and the little granules or *cytoblasts*, as they are termed; but, by a mysterious, unknown power, some of these cytoblasts increase in size, and from the surface of each arises a delicate membrane, compared by Quain to a watch-crystal, which, continuing to enlarge, ultimately incloses the granule, and the latter now appears attached to its inner surface (Fig. 1). In this way a perfect cell is formed; what was before a cytoblast is now a *nucleus;* and the delicate membrane, which elevated itself from the surface of the cytoblast, has become the cell-wall. When fully formed, the cell-wall enters immediately upon its duties; which, in general terms, consist in the absorption of the surrounding fluid, the elaboration of certain materials from it, and the rejection of others. These functions, however, are variously modified in the several species of plants. Thus, in those of the lowest order, as the mould and the yeast-plant, each cell is independent, and the entire plant is only a collection of cells, which reproduce themselves indefinitely. But in plants of a higher organization, each primordial cell performs a particular part in the development of some special structure, which is itself partly composed of cells possessing a similar power. The changes which the cells undergo in thus advancing to a state of organization higher than that of simple independent organs, are very numerous; but, for want of space, they cannot all be enumerated here. It must suffice to state: 1, that they may increase in size; 2, alter in shape so as to become polyhedral, flattened, fusiform, or tubular; 3, coalesce to form tubes, or canals; 4, become filled up by secondary deposits, and be elongated into fibres; and, lastly, may generate new cells, daughter cells, in their interiors, in order to supply the places of the mother cells, which, in the course of time, rupture, and are absorbed.

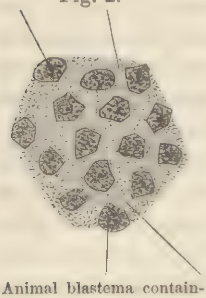
Fig. 1.

Plan representing the formation of a nucleus, and of a cell on the nucleus, according to Schleiden's view.

In the animal economy, the general functions of the original cells do not differ materially from those of vegetables; but the manner in which these little bodies become transformed into different tissues, requires separate mention. It has been already stated that the original cell found in the ovary of the female has, apparently, nearly as simple a structure

as that of the vegetable mould, the simplest of all organized substances; not the least indication can be observed of the changes which it is afterward to undergo. This cell, however, having been impregnated, and transferred with its special surroundings to the cavity of the uterus, generates new cells, which arrange themselves into groups, and become the seat of an interstitial deposit, the peculiar character of which differs in the different groups. These groups, at first irregular and misshapen, assume after awhile a definite form; the deposit in their cells, meantime, changes in color and increases in consistence; and now, for the first time, may be recognized the outline of some organ or part of the future body—it may be a liver, an arm, or a leg, the distinction being yet very obscure. These changes continue, the separate divisions increase in size, become more and more consistent, and their outlines still more distinct, and it is not long before some definite shape is given to the whole. In all of these various changes, cells are the active organs, but what determines their grouping and the interstitial changes that they undergo, is still a mystery, and in all probability will ever remain so.

Fig. 2.



Animal blastema containing granules or cytoblasts, and nucleated cells.

The development of the different organs and tissues consists then only in a multiplication and transformation of cells. The manner in which this multiplication occurs is as follows:

Fig. 3.

Diagram of a typical organic cell.

1. New cells may form upon pre-existing cytoblasts, the latter becoming the nuclei of the former (Fig. 1). These nuclei may increase in size, but always less rapidly than the cell-wall, or they may disappear altogether. Of the origin of the cytoblasts nothing certain is known. Schleiden and Schwann suppose that they result from an aggregation of matter around a still smaller body, called a *nucleolus;* but this is only transferring the difficulty, the question then arising as to the origin of the nucleolus.

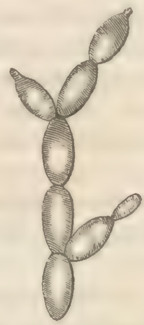
2. New cells may be generated by the nuclei of pre-existing cells (Fig. 2). In this case, several cells are usually produced by one nucleus by a species of cleavage or duplication. The latter are at first contained within the mother cell, which, after awhile, is ruptured or liquefied, and disappears.

3. A new cell may be formed by the agglomeration of certain substances in the blastema, without the aid of pre-existing cytoblasts or cells, and afterward acquire a nucleus (Schwann).

4. New cells may sprout, as it were, from the sides of other cells, but this has been observed only in vegetables, as in the yeast-plant (Fig. 4).

FORMATION OF TISSUES FROM CELLS.—In the production of the several tissues of the body, the cells undergo certain changes, whose nature varies with that of the tissue to be formed. As already mentioned, all the tissues of the body can be reduced to four microscopic elements; namely, molecules or granules, cells, fibres, and amorphous matter. In the production of simple fibre, an entire transformation of the cell is necessary, which takes place in the following modes:

Fig. 4.



Magnified figure of the yeast-plant, *Saccharomyces cerevisiæ.* (After Meyen.)

1. By increasing in size, in particular directions, cells may become elongated, fusiform, or prismatic, and after the cell-wall has become thickened, may be divided into longitudinal strips or fibres. These fibres are at first so closely adherent as to present the appearance of a single large fibre; but they soon separate, and, if a close examination is made, the nucleus, which is afterward absorbed, will be seen lying in their midst. Where a fibre of considerable length is to be formed, a union of the extremities of several cells occurs, so that when the fibre is completely formed, there may be no break. In the development of some of the tissues, the muscular, for example, the cells are disposed in parallel rows, and uniting at their elongated extremities ultimately form bundles of parallel fibres. But in the production of fibrous membranes, areolar tissue, and other structures whose fibres cross each other in every direction, no such arrangement obtains, and the split extremities of the elongated cells branch out on all sides.*

Fig. 5.

Development of the areolar tissue (white fibrous element). 4. Nucleated cells, of a rounded form. 6, 7. The same, elongated in different degrees, and branching. At 7, the elongated extremities have joined others, and are already assuming a distinctly fibrous character. (Schwann.)

2. While changes of figure and size are going on in a cell, its wall and inclosed matters may also become altered. Thus, for instance, the cells of the cuticle, when first formed, are soluble in acetic acid, but they soon lose this property in consequence of changes in the cell-wall. In the adipose and pigmentary tissues, the inclosed matter of the cells does not present its characteristic appearance until some time after their first development.

3. It is probable, but by no means cer-

* Henle is of opinion, that in the development of these latter tissues the blastema itself is converted into fibres without the agency of cells or cytoblasts.

tain, that cells having arranged themselves into rows, may form canals by the absorption of their opposed sides, instead of splitting into fibres.

Changes in the relations of cells occur in several ways:

1. Cells may remain entirely independent, and in this condition constitute an essential element of certain fluids, as in the blood, lymph, and chyle, in which they are freely suspended, as in a blastema.*

2. They may become isolated by the development between them of fibres which soon constitute the greater part of the tissue.

3. They may become arranged in one or more layers upon the surface of a basement membrane of a fibrous character. This is the case in the epithelia of serous and mucous surfaces and the epidermic layer of the skin.

The development of all the tissues takes place after one or more of the preceding modes, but it has been supposed by Henle and Mandl that tissues may also originate immediately from the blastema, and even from the nuclei.

AREOLAR OR CONNECTIVE TISSUE.

The Areolar or Connective Tissue, called, until lately, cellular tissue,† exists throughout nearly all parts of the body, binding them together and forming a component element of their intimate texture. It is particularly well seen beneath the skin, where it presents itself as a soft, white, filamentous substance, connecting the integument more or less loosely to the subjacent muscles. It is here called *subcutaneous areolar tissue*, and when examined with an ordinary pocket-lens, or even with the naked eye, it will be found to consist of minute threads or filaments, crossing each other in all directions, and forming meshes or interspaces, of various sizes and shapes, which communicate with each other on every side. In the natural condition, these interlinear spaces (areolæ) are exceedingly small, and in order to be readily seen must be distended with air or fluid. They are said to contain a minute quantity of serous or albuminous fluid, but this has never yet been obtained in a separate state, and it is most probable that it is present only in the form of a vapor, which keeps the tissue moist and soft. In consequence of its great extensibility and elasticity, it allows large dropsical accumulations to take place in its interstices, and returns again to its natural condition when the fluid is removed. In some other localities, as for instance under the serous and mucous surfaces, where it is known as the *submucous* and the *subserous areolar tissue*, it is more compact and dense; but here, too, its principal use is that of a connecting medium. Again, it is spread out in the form

* Mandl contends that the blood globule is only a nucleus of a pre-existing cell, whose walls have become liquefied.

† The term "areolar" is preferable to "cellular," as the latter is frequently applied to structures composed of cells.

of a membrane, forming a special covering for every separate organ, and termed, in these situations, *investing areolar tissue.* Lastly, it is distributed through, and forms an important ingredient of, nearly every compound structure in the animal system, however different their general characters and functions; here it is denominated *constituent areolar tissue.* Being, therefore, nearly everywhere present, it has several distinct uses: in one place serving as a bond of union; in another, that of a confining investment; and in another, that of a supporting framework.

Areolar tissue possesses little or no sensibility. In the living subject it may be cut or torn in any direction without producing pain, except what may arise from injury to nervous filaments passing through it to adjacent parts. It is also but sparsely supplied with bloodvessels, for although in many situations a vast number of vessels are found ramifying in its substance, these are destined to other structures in the vicinity; only here and there may be seen a small twig distributed to the tissue proper. It may be readily inferred, therefore, that the vitality of this tissue is exceedingly low, and this is farther proved by the rapidity with which it dies when attacked by inflammation.

What is here stated of bloodvessels is also true of lymphatics or absorbents, which, while they abound in areolar tissue, do not belong to it. Their presence, however, together with that of numerous veins, is sufficient to account for the disappearance of œdematous accumulations which is frequently observed, and also the rapid absorption of medicinal and other fluid substances introduced beneath the skin.

Areolar tissue may be almost entirely converted into gelatin by protracted boiling; and since nearly all the organs contain more or less of this tissue, they too will furnish gelatin when submitted to the same process.

Structure.—When submitted to the microscope, areolar tissue is found to consist of fibres and cells. The fibres are of two totally distinct kinds, known as *connective* and *elastic.*

The connective fibres (Fig. 6) are perfectly transparent and so delicate as to be scarcely measurable. They are arranged into fasciculi or bundles of various sizes, present an undulating or wavy outline, and are always parallel in the same bundle. It has been also observed that although they may pass from one fasciculus to another, they never anastomose or divide.

The elastic fibres (Fig. 7) are far less abundant than the preceding, but of much larger size, some of them measuring not less than $\frac{1}{200}$ of a line in thickness. They are colorless but have a well-defined dark outline; are not usually found in fasciculi, but mingled indiscriminately with the other variety, and show a remarkable tendency to curl up at their ends. They are easily demonstrated by moistening the specimen with

acetic acid or dilute caustic potash, by which means the connective fibres are dissolved while the former remain unaffected.

Fig. 6.

Filaments of areolar tissue, in larger and smaller bundles, as seen under a magnifying power of 400 diameters. Two or three corpuscles are represented among them.

Fig. 7.

The two elements of areolar tissue, in their natural relations to one another. 1. The white fibrous element. 2. The yellow fibrous element, showing the branching or anastomosing character of its fibrillæ. Magnified 320 diameters. (Todd and Bowman.)

The existence of cells in areolar and fibrous tissues was first conclusively demonstrated by Virchow in 1851, whose pathological views in connection with the same have been widely adopted in Germany and England. They are called by their discoverer plasmatic cells, and are described as "minute corpuscles, sometimes fusiform, but more frequently star-shaped, with sharp outlines, and connected with each other by means of their branching prolongations, so as to constitute a network similar to that formed by the cells of bone."* They are more clearly seen in the tendinous structures than in loose areolar tissue, and, under certain circumstances, are said to undergo transformation into cartilage or bone.

VASCULAR TISSUE.

This tissue, as its name indicates, consists of vessels; and, as will be understood after its structure has been described, is more properly an organ than a simple tissue. It admits of two principal divisions, namely, bloodvessels and lymphatics.

BLOODVESSELS.

The Bloodvessels form a system of membranous elastic tubes, of various sizes, distributed throughout every organ and nearly every tissue of the body, for the purpose of circulating the blood. They are divided into

* Morel.

two classes, arteries and veins; to which is sometimes added a third, called the capillaries. The arteries originate by two large trunks from the ventricles of the heart, from which, branching out in every direction, they conduct the blood to all parts of the body. The veins, on the contrary, commence in the remote parts of the body by small radicles, which unite to form large trunks. They communicate with the auricles of the heart, and return the blood to this, the central organ of the circulation. The capillaries are a network of delicate vessels, intermediate between the terminal branches of the arteries and the rootlets of the veins, but not properly distinct from either.

Arteries.—The arteries are of two kinds, namely, the systemic and the pulmonic. The former carry florid blood to the system at large, and the latter dark blood to the lungs. Thus, taking the heart as the starting-point, two main trunks pass off from the two ventricles of this organ, one called the pulmonary artery, and the other, the aorta; and these, dividing and subdividing, ramify minutely, the former in the lungs, and the latter in the general system. The two may be represented, therefore, by two trees of unequal size, whose trunks, the pulmonary artery and aorta, are connected with the heart. The following remarks, however, are intended to apply more particularly to the larger or systemic tree, formed by the aorta and its subdivisions.

Division.—The mode in which arteries divide into smaller ones varies very greatly in different parts of the body, and is subject to no general laws. Thus, a single artery may bifurcate, *i. e.* resolve itself into two of nearly equal size, and this usually takes place at an acute angle. From a main trunk numerous small collateral branches may be given off, and thus the vessel gradually diminishes to a very small size. These collateral vessels generally come off at an acute angle, but sometimes at a right, or even at an obtuse angle, and their number does not always proportionally diminish the size of the common trunk. Again, most arteries give off branches at very short intervals; but a few run a considerable distance without furnishing a single offset, until they reach the organs for which they are intended, as, for instance, the common carotid, spermatic, and umbilical arteries. Notwithstanding these divisions and subdivisions, there is an uninterrupted communication between every part of the arterial system; this is effected by what is called *anastomosis* or *inosculation*, which may occur through the intervention of intermediate branches, by the coalescing of two arteries to form one, or by two arteries coming toward each other and uniting in a common arch.

Direction.—The general direction of the principal arteries is straight, but the smaller divisions are always more or less flexuous. Exceptions are found in the cardiac, labial, splenic, and internal carotid arteries; which, although large, are more or less tortuous.

Situation.—As a general rule, the principal arteries are found in the most protected parts of the body. Thus, in the extremities, they lie deep upon the inner sides of the limbs, and along the flexures of the joints. They are also nearly always surrounded by more or less loose areolar tissue, especially in the great cavities of the body, and in the neighborhood of the joints.

Capacity.—The number of the successive divisions of the arteries, commencing at the aorta, is about twenty. At each one of these divisions, with a few exceptions, there is an increase of capacity; that is to say, the united capacities of the branches exceed that of the main trunk. This increase, however, is not as great as is generally supposed, owing to the erroneous method of computation which most anatomists have adopted. This error, which was first pointed out by Cruveilhier, consists in taking the diameters of the tubes as the measure of their capacities, whereas the proper method is to take the squares of the diameters. At first thought, it would seem that this successive increase of the capacity of the arterial system—which has been ingeniously compared to a cone with its apex at the heart—would operate to retard the flow of blood in the remote branches; but, as Bichat correctly remarks, this can have but little effect in a system of communicating and permanently distended tubes.

The arteries in all parts of the body terminate ultimately in the veins. This communication, however, is not direct; the vessels divide and subdivide, until they become too small to be seen with the naked eye; and if they are traced out by means of a microscope, their minute divisions will be found forming a part of that network of vessels called capillaries, from which the rootlets of the veins take their origin.

Physical Properties.—The most remarkable of the physical properties of the arteries is their elasticity. This is manifested in their prompt retraction after they have been greatly extended, and in their contraction and retraction when divided. The patulous or open condition in which they are found after death also exhibits the same property.

Vital Properties.—Arteries are not endowed with sensibility, but they possess a certain degree of vital contractility. This latter property, whose existence was for a long time denied, exhibits itself in a slow, rhythmic, successive diminution of the caliber of the tube in the direction of its terminal branches, in which it is more manifest than in the larger trunks. It is, therefore, unlike muscular irritability, which is spasmodic and irregular; and, to distinguish it from this, it is called "tonic" contraction. It may be seen in the small arteries of the web of a frog's foot, placed under a microscope, the vessels being stimulated by pricking with the point of a needle, or by the contact of some irritating fluid.

Structure.—The arteries are compound in their structure. They have three distinct cylindrical layers or coats, which are placed one within

another, and connected by areolar tissue. Besides these three proper tunics, each artery is surrounded by a sheath of condensed areolar tissue, which, in some instances, incloses other structures also; as in the neck, where one common sheath surrounds the carotid artery, jugular vein, and pneumogastric nerve. The medium of union between the sheath and its included artery is loose areolar tissue, which allows the vessel, when cut across, to retract a considerable distance within.

The *external coat* of the artery is a dense, strong membrane, somewhat resembling the sheath. It consists principally of closely interwoven filaments of areolar tissue. Its thickness varies in different parts of the body, but it is proportionably greater in the small than in the large branches. In the arteries of the uterus, and in some other instances, it is entirely wanting. It is best seen in the large trunks, from which it can be readily dissected. Although it may be considerably extended, it has no elasticity. It is upon this layer that the strength of the vessel mainly depends; and, in the application of the ligature, it is the only one of the three that remains intact, the two others being completely divided, if the knot is firmly drawn.

By means of the microscope, the external coat may be resolved into two distinct laminæ: an internal, of genuine elastic tissue; and an external, of common areolar tissue, closely condensed.

The *middle coat* is the thickest of the three, although varying very greatly in thickness in different parts of the system, and, like the external, it is sometimes entirely wanting. It is of a reddish-yellow color, firm, and rather dry; and consists of distinct fibres, disposed in a circular or spiral manner around the vessel. In the large arteries it may be divided into many layers, united to each other by short areolar tissue, and by an interchange of fibres. In the small branches it consists of only a single layer, too thin to be divided, although it forms the chief thickness of their walls. Its most remarkable property is its elasticity, which exceeds that of any other tissue in the human body. It is principally owing to the firmness and elasticity of this coat, that the arteries remain patulous after death, and contract and retract when divided.

Under the microscope, the fibres of the middle coat are found to be of two kinds: the one consisting of fine, yellow, elastic filaments like those found in areolar tissue (Fig. 7), joined together in an irregular network; and the other, of pale, soft, translucent fibres, measuring about $\frac{1}{4000}$ of an inch in diameter, and presenting here and there the remains of nucleated cells; the latter belong in all probability to the class of involuntary muscular fibres.

The *internal coat* lines the internal surface of the middle coat, to which it is intimately connected. It is very delicate, smooth, almost transparent, tolerably elastic, yet easily torn; and, unlike the two other coats, has a free surface for contact with the blood. At the mouth of the aorta this

membrane forms three folds, called the semilunar, sigmoid, or aortic valves, whose office is to prevent the reflux of the blood into the left ventricle of the heart. In other situations, we sometimes find small longitudinal, or even transverse folds, which are produced by the contraction of the artery, and disappear when it is distended.

This coat is so closely adherent to the preceding that it cannot be readily dissected. Under the microscope, it will be seen to consist of two distinct laminæ: the internal lamina is a tesselated epithelium (see *Epithelial Tissue*); the other seems to be made up of very minute, pale fibres, which follow a longitudinal direction, and anastomose obliquely. It is remarkable for numerous small oval perforations, from which it has been named the "perforated" or "fenestrated membrane."

The walls of the arteries are plentifully supplied with arterial blood, by numerous small arterial twigs called *vasa vasorum*, which do not usually come from the vessels to which they are distributed, but from neighboring branches. They divide very minutely in the sheath and areolar coat, and some of the smallest enter the middle coat, but none have ever been traced into the internal. These vessels, with the little venous radicles in which they ultimately terminate, form an intricate network in the outer tunic of each of the arteries, even to their smallest subdivisions.

The arteries are entirely devoid of sensibility; and it is, therefore, probable that they receive very few if any nerves from the cerebro-spinal system; but that they are abundantly furnished with filaments from the sympathetic system, not only in the splanchnic cavities, but also in the extremities, there can be little doubt.

Veins.—The veins are distributed throughout every part of the body, for the purpose of receiving the blood and returning it to the heart, after it has passed through the arteries and undergone certain changes in its course. They commence by minute radicles which unite to form larger branches or trunks, which ultimately terminate in the right auricle.

Like the arteries, the veins belong to two general classes: the one, called "pulmonary," originating in the lungs, and terminating in the left auricle; the other, named "systemic," commencing in the body at large, and opening into the right auricle. The blood conveyed by the pulmonary veins is florid or arterial, and that by the systemic division, venous or dark blood.

The veins are much more numerous than the arteries; they are also more capacious, and their anastomoses are larger and more frequent. They are conveniently divided into two sets—one superficial, the other deep—names which sufficiently indicate their relative position. The *superficial* or *subcutaneous veins* are most numerous and largest in parts in which the circulation in the deep set is liable to be obstructed

by muscular contraction; as, for instance, in the extremities, where they form a collateral route for the blood.

The *deep veins* accompany the arteries, and are hence called the *satellite veins* (*venæ comites*); the largest arteries have generally one, and the medium-sized two, one on each side. They are contained in the same sheath with the arteries, to which they are connected by areolar tissue, sometimes so closely as to require great skill to dissect them apart. In the dura mater, liver, and some other deep structures, the veins do not attend the arteries.

The anastomoses between the veins are in all situations large and numerous, and particularly so in parts where the circulation is liable to obstructions; as, for example, around the neck of the bladder and lower portion of the rectum, where they form a most intricate network or plexus.

The course of the veins, like that of the arteries, is generally straight; but to this there are numerous exceptions, the most remarkable example of which is seen in the veins of the gravid uterus.

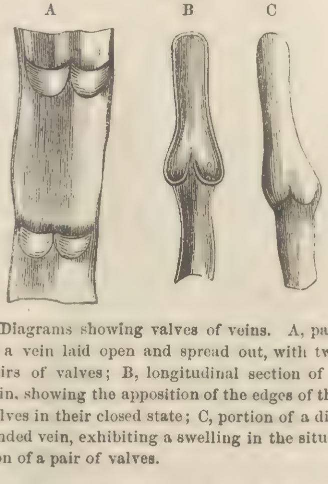
STRUCTURE.—The walls of the veins are much thinner than those of the arteries; and hence, when empty, they do not retain their cylindrical form, but collapse. They are composed, however, with some exceptions, of three coats or tunics.

The *external coat*, although dense and strong, is somewhat thinner than that of the arteries, to which it is exactly similar in structure.

The *middle coat* is but poorly developed, and in many places cannot be demonstrated at all; but, as a general rule, is thicker in the superficial than in the deep veins, and in the large trunks of the splanchnic cavities than in those of the extremities. It is composed of elastic and involuntary muscular fibres which, for the most part, run circularly around the vessel.

The *internal coat* is the essential constituent of the veins, and is sometimes the only one present. It does not differ in structure from the analogous arterial coat, but is somewhat less brittle, and can be dissected off in much larger pieces. In different parts of the venous system this coat forms transverse folds, called "valves" (Fig. 8), which are of a semilunar shape, with their free margins directed toward the heart. They are intended to support the blood, when the circulation propels it in a direction contrary to its own gravity; and, in other situations, to prevent a reflux of this fluid. Valves are not present, how-

Fig. 8.



Diagrams showing valves of veins. A, pair of a vein laid open and spread out, with two pairs of valves; B, longitudinal section of vein, showing the apposition of the edges of the valves in their closed state; C, portion of a distended vein, exhibiting a swelling in the situation of a pair of valves.

ever, in all the veins; as a general rule, they are found only in those situations where natural obstructions exist to the ready return of the blood to the heart; and where these difficulties are greatest, the valves are most numerous. In veins of a medium size, the valves generally occur in pairs, but in those of smaller caliber they are single; while in those of very small size they are entirely wanting. They are also wanting in the veins of the viscera, of the bones, of the dura mater, and in the two cava veins.

The walls of the veins, like those of the arteries, are provided with small nutrient vessels (*vasa vasorum*); they are supposed also to have nerves, whose filaments have, in fact, been demonstrated in one or two of the larger trunks. They possess no sensibility, but in recently killed animals are said to exhibit well-marked vital contractility, which is doubtless due to the pale muscular fibres found in their middle coat.

Capillaries.—The capillary vessels are intermediate between the arteries and veins, and are properly the terminal branches of the former, and the rootlets of the latter. They exist in every organ, and in nearly every tissue of the body, communicating freely with each other, and forming an intricate network or plexus, whose interstices vary in their size and shape in different parts.

The size of the capillary vessels is not uniform; it is generally greater than that of the blood corpuscle, so as to allow the passage of at least one of these bodies at a time. The existence of capillaries so small as to admit the circulation of only the fluid portions of the blood, is not at the present day generally admitted by anatomists.

The closeness of the network formed by the anastomoses of the capillaries is generally in proportion to the importance and activity of the function of the organ or tissue. In the lungs, muscles, skin, and glandular organs generally, the interspaces are very small; but in tendons, ligaments, and other tissues of a low degree of vitality, they are relatively quite large. The shape of the interspaces also varies, being either oblong, round, or polygonal, according to the arrangement of the minute particles of the texture.

Fig. 9.

Plan representing the terminal twig of an artery, and a venule with capillaries intervening.

STRUCTURE.—In the smallest capillaries (those that have a diameter of about $\frac{1}{3000}$ of an inch, or less), the walls seem to consist of a single, transparent, homogeneous membrane, whose external surface presents numerous oblong nucleated cells, arranged with their long axes corresponding to that of the vessel. In those of larger size an

epithelium may be discovered upon the internal surface of this homogeneous membrane; and, upon its external surface, a thin coat of condensed areolar tissue. The change from arteries and veins to capillaries is marked by the gradual disappearance of the structures composing the three coats of the former, and their substitution by the structureless membrane peculiar to the latter.

It is most probable that the capillaries possess vital contractility, but this has not yet been clearly demonstrated, although they have long engaged the closest study of physiologists.

ABSORBENTS OR LYMPHATICS.

These are a set of minute vessels that originate in the remote parts of the body, and terminate by two main trunks in the veins of the neck. They are divided into two classes; the lymphatics, properly so called, and the lacteals. The former are distributed throughout the body at large, and contain the lymph; the latter are connected with the intestinal canal, for the purpose of taking up the chyle. On account of their small size, the thinness of their coats, and the transparency of the fluid which they contain, they are not readily seen with the naked eye; but, with an ordinary magnifying-glass, they may be discovered threading their way through almost every organ and tissue of the body. The only organs in which they have not yet been detected are the brain, spinal cord, placenta, and fœtal membranes. Like the veins, they are considered as consisting of a superficial and deep set. The former are situated in the areolar tissue, beneath the skin and the membranous envelopes of the organs; the latter are in company with the large bloodvessels and nerves.

Fig. 10.

Lymphatic capillary network of the skin of the ear.

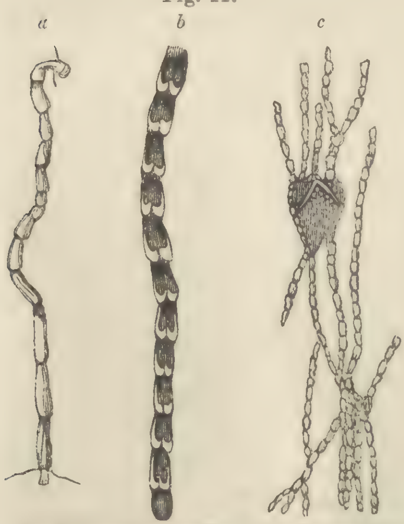
Origin.—But little is as yet known of the origin of the lymphatics; we only know that the minute radicles of those placed beneath the skin and mucous membranes form, in these situations, an intricate plexus, from which single vessels pass off, and, after traversing the little bodies called lymphatic glands, they unite with other branches to terminate in one of the two large trunks. In the substance of the intestinal mucous membrane, however, the radicles of the lacteals may be often traced into the villi, where they form a simple anastomosis; but the exact manner in which they begin, whether by open mouths, as has been supposed by many, or by blind extremities, has not been determined.

Termination.—The principal of the two large trunks of the lymphatic

system is called the *thoracic duct.* It commences by a slightly dilated extremity, named the "chyle receptacle" (*receptaculum chyli*), in the posterior part of the abdomen, lying upon the front of the lumbar vertebræ, between the inferior cava vein and the aorta. It ascends along the front of the spine into the cavity of the thorax, in the upper part of which it bends forward and to the left, passes behind the left clavicle, and there opens into the confluence of the corresponding internal jugular and subclavian veins. The other trunk is much smaller, is situated deep upon the lower part of the right side of the neck, and terminates at the juncture of the left internal jugular and subclavian veins.

Structure.—The walls of the lymphatic vessels are quite thin, but their general structure is similar to that of the arteries and veins. Three coats are recognized: 1, an *external* of condensed areolar tissue; 2, a *middle*, consisting almost exclusively of unstriped or involuntary muscular fibres, arranged for the most part in a circular manner; and 3, an *internal* lining membrane of tesselated epithelium. The last mentioned, like the lining membrane of veins, is thrown into numerous transverse semilunar folds or valves for strengthening the vessels and preventing the retrograde movement of the contained fluid. These valves generally occur in pairs, but are in many instances single, and are particularly abundant where the vessels anastomose. Their presence accounts for the knotted appearance of the vessels when they are injected.

Fig. 11.



a, lymphatic vessel; *b*, another lymphatic vessel, showing the arrangement of the valves; *c*, lymphatic vessels connected with a lymphatic gland.

The lymphatics, like the bloodvessels, are supplied with minute nutrient arteries and corresponding veins. They also possess well-marked vital contractility.

The **Lymphatic Glands** or **Ganglia** are small, oval-shaped, fleshy-looking bodies, lying in the course of the lymphatic and lacteal vessels. They are found in large numbers in the neck, mesentery, thorax, armpits, and groins. Their size varies from that of a grain of wheat to that of a common white bean. They consist essentially of divisions of the vessels arranged in a tortuous manner, bound together by areolar tissue, and freely supplied with bloodvessels. Upon

entering one of these glands, the lymphatics, called here the *vasa afferentia*, break up into a large number of branches, or more properly open into a cavernous structure forming the exterior or *cortical substance* of the organ, the cavities or alveoli of which communicate freely with each other and with the convoluted tubes of the medullary portion occupying the centre of the organ. The wall or septum of the alveoli is a soft pulpy granular material in which may be discovered the elements of areolar tissue, a large number of clear round bodies like follicles,* and a plexus of minute capillaries. The *medullary substance* seems to consist of convoluted vessels which are the radicles of the vessels (*vasa efferentia*), which leave the organ and unite to form one or more trunks of larger size. The exterior of the gland is invested by a very thin expansion of areolar tissue. Although apparently essential to the lymphatic system, ganglia are not connected with all the vessels; and in some instances the same vessel passes through two or three of these little organs. Their office is not known, but they are supposed to be concerned in the elaboration of the white corpuscles which exist so abundantly in the lymph. They are subject to a deposition of black pigment at the roots of the lungs, and in all situations liable to hypertrophy, and tuberculous and cancerous degeneration.

CHYLE, LYMPH, AND BLOOD.

Chyle and Lymph.—The *chyle* is an opaque, milky-looking, viscid fluid, contained in the lacteal vessels, which receive it from the stomach and small intestines, where it is formed. It has frequently a pinkish color, which is said to be heightened on exposure to the air, or to oxygen gas. It possesses little or no odor, and a very slightly alkaline taste. When drawn from the living body, it coagulates spontaneously, a phenomenon that is due to its fibrinous element; and as the fluid contains a greater proportion of fibrin after it has passed through the lymphatic glands, so in this condition its coagulation is more rapid and the clot firmer, than when it has been obtained from the vessels in the first part of their course.

Besides this increased coagulability, the appearance of the chyle is somewhat altered after the fluid has passed the lymphatic glands; the opacity in a great measure disappears, and the pinkish hue becomes more marked, or is replaced by a yellowish tinge.

Composition.—The following is Dr. Rees's analysis of the chyle of the ass, drawn from the lacteals just before their entrance into the thoracic duct, and, of course, after they had passed through the mesenteric lymphatic glands:

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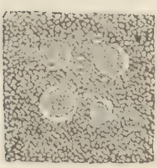
* Kölliker.

Water	90·237
Albuminous matter	3·516
Fibrinous "	·370
Fatty "	3·601
Extractive and saline matter	2 276
	100·000

Dr. Rees also examined the contents of the thoracic duct of an executed criminal, an hour and a half after death, and found it to contain less water, more albumen, less extractive matter, and much less fat than that of the ass; but, as the individual had taken little or no food for some hours before execution, this can hardly be considered as a fair analysis.

Examined with the microscope, the chyle is found to consist of a clear, transparent fluid or "plasma," holding in suspension three kinds of solid matter: 1. Pale, colorless corpuscles (Fig. 12), of a rounded and slightly flattened figure, about $\frac{1}{3000}$ of an inch in diameter. They vary in number in the fluid taken from the vessels in the first part of their course, but after the latter have traversed the mesenteric lymphatic glands they become very abundant. They consist of a delicate homogeneous membrane inclosing a transparent, granular, semiliquid substance, and a nucleus; and are not distinguishable from pus corpuscles. 2. Numerous separate granules floating in the plasma. 3. A few oil globules, and small spherical bodies supposed by Gulliver to be of an albuminous nature. The clear liquor or plasma holds the fibrin in solution, which, upon coagulating, incloses most of the solid constituents in its meshes, leaving a thin serous fluid, composed of water, fatty matter, salts, and extractive.

Fig. 12.



Molecular base of chyle with chyle globules.

The origin of the corpuscles is not positively determined, but it is most probable that the larger proportion is derived from the mesenteric glands. Those found in the afferent vessels are supposed to come from the agminated and solitary glands of the small intestine.

The *lymph* is a thin, pale yellow, clear fluid, contained in the lymphatic vessels properly so called. Like the chyle, it has a slight alkaline reaction, assumes a pinkish color upon exposure, and separates spontaneously into a firm gelatinous clot, and a surrounding yellow fluid, about the consistence of thin cream. Examined with a microscope before coagulation, it seems to be composed of the same constituents as the chyle; the only difference being in the oil globules, which are less numerous than in the latter fluid. The coagulation of the lymph, like that of the chyle, is due to its fibrinous constituent, which is held in solution by the liquid plasma or blastema.

The chemical composition of a quantity of lymph drawn from a

vessel upon the instep of the foot, was found by Marchand and Colberg to be—

Water	96·92
Fibrin*	·52
Albumen	·43
Fatty matters	·27
Osmazome, and various salts	1·86
	100·

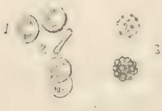
The Blood.—The blood is contained in the heart and bloodvessels; and, to the naked eye, is a homogeneous fluid, of a bright red color in the arteries, and a deep purple hue in the veins. Its specific gravity varies from 1050 to 1060, water being 1000; and its temperature from 96° to 100° F.; it has a weak alkaline reaction, a saltish taste, a peculiar faint odor, and a clammy or sticky feeling when rubbed between the fingers. Its quantity varies in different individuals, at different ages, and under different conditions of the system, but is estimated to average about one-eighth or one-tenth the weight of the entire body. When drawn it soon coagulates and separates into two parts, the one a firm, elastic, solid substance, of a deep red color, called the *crassamentum* or clot, and the other a thin watery fluid, of a pale yellow tint, called the *serum*. The time required for this change varies from a few seconds to eight or ten minutes, according to the state of the blood itself, the manner in which it is drawn, the size and shape of the vessel, the temperature of the surrounding atmosphere, and several other circumstances that cannot be here enumerated. Blood obtained from persons of a full plethoric habit coagulates more slowly than that taken from those who live abstemiously. When the blood is drawn from a large orifice, and received into a deep cup, the process is comparatively tardy; but if the orifice is small, and the receiving vessel shallow, it is almost immediate, and this is especially the case when the air is very warm.

Microscopic Characters.—Under a microscope of medium power, the blood may very readily be seen to consist of an almost colorless fluid, holding in suspension numerous little corpuscles or globules. The clear fluid, commonly called the plasma or blood liquor (*liquor sanguinis*), is the coagulable part of the blood; it is composed of water, fibrin, albumen, and various salts. It must not, therefore, be confounded by the student with the serum, which is only the blood liquor deprived of its fibrin by coagulation. The corpuscles are of two kinds, the colored and the colorless, or, as they are commonly termed, the red and the white globules.

* The fibrin is in all probability more abundant in vessels nearer the central trunks.

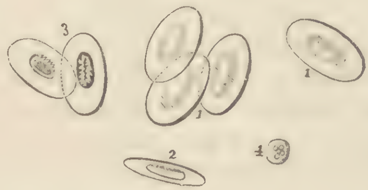
The *red corpuscles* vary in shape and size in the different genera and species of animals. They are not, strictly speaking, globules, but in man, and in all other mammalia except the camel, they present themselves as small circular disks (Fig. 13), like biscuits, with a slight depression upon the centre of each surface. They are, therefore, thicker

Fig. 13.



Red corpuscles of human blood, magnified about five hundred diameters (Wagner). 1, shows depression on the surface; 2, a corpuscle seen edgewise; 3, red corpuscles altered by exposure.

Fig. 14.



Corpuscles of frog's blood, magnified about five hundred diameters. 1, 1, their flattened face; 2, a corpuscle turned edgewise; 3, blood corpuscles altered by dilute acetic acid; 4, a lymph globule.

at their margins than in the middle, and when looked at edgewise resemble a double concave lens. Exposed for a few minutes to the air they become shriveled, and sometimes jagged upon the edges; and when placed in pure water or dilute acetic acid they swell, become very indistinct, and presently burst.

The size of the red corpuscle differs not only in different classes and species of animals, but also in the different individuals of the same species. In the human subject they are about $\frac{1}{3500}$ of an inch in diameter, and one-fourth less in thickness. Among mammalia, the largest are found in the elephant, and the smallest in the Napu musk deer (Gulliver). In the former, they measure $\frac{1}{2700}$, and in the latter $\frac{1}{12000}$ of an inch in diameter. In birds, reptiles, and fishes, they are much larger; those of the frog (Fig. 14), for instance, are of an oval figure, and in their longest diameter measure about $\frac{1}{1000}$ of an inch.* Each corpuscle consists of an envelope and an inclosed matter. The envelope, called the *capsule*, is a thin, delicate, transparent, and apparently homogeneous membrane, insoluble in water, but readily dissolved by ether and strong alkaline fluids. The inclosed substance, in which is contained the coloring matter of the blood, is a semifluid, of a pale yellowish-red tint, and in the frog incloses a well-marked nucleus. In recently drawn blood they manifest a remarkable attraction for each other, and may be observed to run together so as to form rolls resembling piles of coin (Fig. 15).

The *white corpuscles*, or, as they are sometimes called, the lymph globules (Fig. 14, 4), do not exist in great numbers in the blood of mam-

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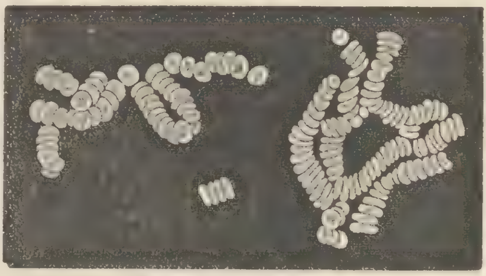
* The corpuscles of the proteus and siren, belonging to the same class of animals as the frog, are said to be $\frac{1}{400}$ of an inch in length.

mals, only one or two being generally seen in the field of the microscope; but they are very abundant in that of the naked reptiles, in whose transparent parts—as the web of a frog's foot or the fin of a fish—they may be distinctly seen rolling along with the others. They are spherical, granular, perfectly transparent, and colorless. In man they are a little larger, and in reptiles much smaller than the red corpuscles. Immersed in water or acetic acid they enlarge, exhibit a delicate capsule, rupture, and release one or more minute granules. These are, in all probability, the same corpuscles that are found in the chyle and lymph, and are supposed to be ultimately transformed into red disks.

Fig. 15.



Rolls of blood corpuscles.

Besides the colored and colorless corpuscles, the blood sometimes contains oil globules, and also minute granules or molecules. The nature of the latter is not ascertained.

Chemical Composition.—The *proximate chemical constituents* of the blood, according to Lecanu, are about fourteen in number, of which the principal are water, albumen, fibrin, hematosin or coloring matter, extractive matter, and various salts. The number of *ultimate* elements has been variously estimated, but the most important are oxygen, hydrogen, carbon, nitrogen, sodium, potassium, calcium, iron, silicon, and manganese. The substances which most interest physiologists and pathologists are the red corpuscles, fibrin, albumen, salts, and water. The relative proportions are stated by Lecanu as follows:

Red corpuscles	127
Fibrin	3
Albumen and other dissolved animal matters	72
Salts	8
Water	790
	1000

These proportions are not the same in all individuals. Andral found the red corpuscles to vary, within the limits of health, from 110 to 140; the fibrin from $2\frac{1}{2}$ to $3\frac{1}{2}$; pure albumen from 68 to 70; and water from 790 to 800 in the 1000.

The red corpuscles constitute by far the largest part of the organic or solid matter of the blood, and yield, on analysis, 1, fibrin; 2, a colorless substance nearly allied to albumen, and called globulin; and 3, a coloring material named hematosin or hematin.

The *fibrin* of the blood exists in solution in the blood liquor, and is distinguished from albumen, which it closely resembles in composition, by its spontaneous coagulation. It is not, probably, so actively engaged as the red corpuscles in carrying on the great functions of respiration and circulation, by which the animal temperature is maintained, and life and vigor given to every organ and tissue; but its office, not less important because more obscure and quiet, consists in nourishing and repairing the structures. When obtained in a separate state by stirring fresh blood with a bunch of twigs, or by washing the clot, it is found to be a white, soft, stringy substance, elastic to a moderate degree, of about the consistence of boiled macaroni, and entirely devoid of taste or smell. Being largely increased in quantity in inflammatory states of the system, it forms upon the surface of blood drawn under these circumstances a distinct layer, called the "buffy coat." This is often quite tough and firm, and may be dissected off from the clot in the form of a membrane which varies from the most delicate film to a fourth or even half an inch in thickness.

It is insoluble in water, alcohol, and ether, but is readily taken up by solutions of the caustic alkalies, destroying at the same time their alkaline properties. According to Dumas, its composition is, carbon 52·78, hydrogen 6·96, nitrogen 16·78, and oxygen 23·48. Reduced to ashes, it furnishes chiefly phosphate of lime, and a little phosphate of magnesia.

The *albumen* may be obtained from the serum, in which it is dissolved, by heat or by precipitation with alcohol. Freed from all foreign matters, it is an opaque, white, homogeneous substance, soft but elastic, insoluble in water, but rapidly dissolved by the caustic alkalies. Aside from its assisting to give to the blood liquor a consistence that fits this fluid for circulation, and for the suspension of the red corpuscles, it seems to be the material from which fibrin is elaborated, and this is probably its chief use in the animal economy. Its composition is, carbon 54·38, hydrogen 7·14, nitrogen 15·92, oxygen 22·56, and a small quantity of sulphur and phosphorus.

The *oily* or *fatty matter* of the blood is found principally in the serum, although a small quantity may also be obtained from the fibrin and red corpuscles. It may be easily separated by adding to the serum about one-third of its bulk of ether, with which it readily mixes. According to Lecanu, its usual proportion is about 5·15 to the 1000 of blood; but its quantity is variable, and is sometimes so greatly increased as to give to the serum a turbid, milky appearance.

The *salts* of the blood are—1. Combinations of soda, potassa, and ammonia, with muriatic, lactic, carbonic, phosphoric, and sulphuric acids; 2. Combinations of lime and magnesia with phosphoric, carbonic, sulphuric, and lactic acids. Their presence is essential to the preservation of the red corpuscles in their natural shape and size; and, probably,

also to the fluidity of the fibrin, and the due oxygenation of the blood in the lungs.

The *water* of the blood, as previously mentioned, forms about 790 parts in 1000; but it is obvious that this proportion will be increased or diminished according to the variations of the other constituents.

According to the experiments of Bischoff and Magnus, the blood holds in solution, as it were, certain quantities of oxygen, nitrogen, and carbonic acid gases, which, as the following table from Magnus indicates, vary in their relative proportions in the two kinds of blood:

Gases.	Arterial blood.	Venous blood.
Carbonic acid	7·10	5·35
Oxygen	2·65	1·21
Nitrogen	1·35	1·13

NERVOUS TISSUE.

The Nervous Tissue, constituting what is generally termed the nervous system, is a soft, white, or grayish substance, forming in certain situations large masses denominated nervous centres, from which it is prolonged into all parts of the body in the form of cords called nerves. These two divisions bear nearly the same relation to each other that exists between the bloodvessels and the heart. The central masses are *axes* of power; they receive impressions from different parts of the body through the medium of the nerves; they originate influences excited by these external impressions; and lastly, one of these masses, the brain, is the seat of spontaneous or independent functions, known as the intellectual faculties. The nerves constitute the *peripheral* portion of the system in contradistinction to the masses which form the *central* portion. They are simply conductors, conveying influences or impressions to or from the centres, and are hence said to be internuncial or message-bearing.

The nervous system, as was first pointed out by Bichat, is susceptible of division into two great systems, called the animal and the organic, both consisting of central and peripheral portions. The *animal system* has for its principal centre the brain and spinal cord (cerebro-spinal axis); and for its periphery, forty-three or forty-four pairs of nerves, which are distributed to the skin, the organs of the senses, and the voluntary muscles. Upon it depend sensation, perception, and volition. The *organic* or *sympathetic system* has numerous centres, which consist of small fleshy-looking bodies called *ganglia*,* situated for the most part immediately in front of the spinal column. By means of connecting filaments, they form a chain or series extending from the skull to the coccyx. The nerves, the

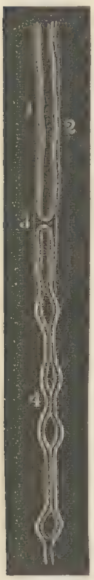
Ganglia also occur upon the posterior roots of the spinal nerves, and upon some of the cerebral nerves, as will hereafter be seen.

peripheral portion of this system, are distributed to those organs and tissues whose functions (nutrition, secretion, etc.) are directly concerned in the maintenance of the body, and which are, to a certain extent, performed independently of the mind.

The nervous system is composed of two very different structures, one called the white or medullary substance, and the other the gray or cineritious; names derived from appearances recognized by the naked eye.

The *white substance* is tolerably firm, resisting, and inelastic; and, in the animal system, constitutes nearly the whole of the nerves, and the greater portion of the central axis. In the former situation, it appears in the form of threads or filaments, bound together in bundles of various sizes; but in the latter, it is a consistent cheesy-looking mass, which may also be resolved into fibres when it has been hardened in alcohol, or some other fluid capable of coagulating its albumen.

Fig. 16.



Varicose tubular white nerve fibre. (After Todd and Bowman.) 1, 2, the natural aspect; at 3, the white substance and axis cylinder are interrupted by pressure, at the same time that the tubular membrane remains entire; at 4, the fibre assumes a knotted character in consequence of mechanical displacement of the neurine. These varicose enlargements were thought by Ehrenberg to be natural and to exist during life; but later observations prove them to be altogether factitious.

The *gray* or *cineritious substance* exists in greatest abundance in the cerebro-spinal axis, the ganglia, and the sympathetic nerves. In all these situations, except the last, where it presents a fibrous appearance, it is a soft, inelastic, nearly semifluid mass, apparently homogeneous in structure, but, as will be presently seen, composed of fibres and cells of a peculiar character.

Structure.—The microscopic elements of nerve tissue are sufficiently simple, consisting only of fibres and cells, with a certain amount of free nuclei and granular matter; but the relations which they bear to each other are imperfectly known. The fibres compose all the peripheral parts of the system, the white portions of the central masses, and are found also in the gray substance. The cells exist only in the gray matter of the centres.

Nerve Fibres are of two kinds, the white or tubular and the gray, although the latter are considered by many excellent observers to be only a modified form of connective or areolar fibre.

The *white* or *tubular fibres* (Fig. 16), of which the nerves and the medullary substance are for the most part composed, are arranged in fasciculi or bundles of various sizes, bound together by delicate areolar tissue which furnishes each bundle and each separate nerve with a continuous sheath. They consist of—1, a membranous cylin-

der, called the *neurilemma;* 2, immediately within this a semifluid material called the *medullary sheath;* and 3, a more consistent, transparent, homogeneous matter named the *axis cylinder.* It is probable, however, that the last two are one and the same material, and that the distinctive appearances are due to changes after death. Be this as it may, the primitive fibres, when largely magnified, have a well-marked double contour, and an inclosed transparent substance, sometimes called *neurine*, which, upon exposure, becomes faintly granular. They vary in size from $\frac{1}{4000}$ to $\frac{1}{10000}$ of an inch in diameter; are generally arranged parallel to one another, and, as usually observed, do not present a straight, but a wavy outline, with here and there distinct swellings or enlargements, which are often so numerous as to give them a beaded appearance. It is generally admitted, however, that this beaded or varicose condition is due to pressure or traction during the manipulation necessary for their exhibition, the soft matter within the tubes being made in this way to accumulate at different points. They never unite with each other, as bloodvessels do, in forming anastomoses, but continue unbroken from their central connection to within at least a very short distance of their peripheral terminations.

Fig. 17.

Gelatinous or gray fibre, magnified 320 diameters.

The *gray fibres** (Fig. 17) are most abundant in the gray substance of the cerebro-spinal axis, the ganglia, and the sympathetic nerves. They are solid, homogeneous, flattened transparent filaments, provided with well-marked oval nuclei, and, as before stated, are supposed by many excellent microscopists to be only a peculiar form of connective fibre. In the ganglia they constitute the stroma or matrix in which the other elements are imbedded.

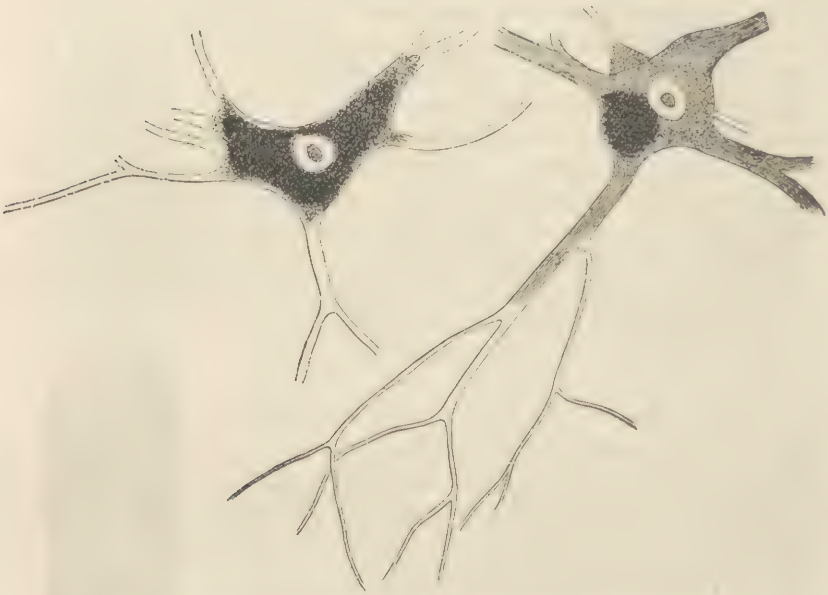
The **Nerve Cells** are found only in the gray substance of the cerebro-spinal axis and in the ganglia. Some of them are spherical, quite large, measuring not less than $\frac{1}{400}$ of an inch in diameter; others, and probably the greater proportion, are remarkable for possessing one, two, or more long tubular processes, and from this circumstance are called *unipolar*, *bipolar*, or *multipolar* cells, according to the number of their branches. They consist each of a delicate wall, soft granular contents oftentimes mingled with more or less pigmentary matter, and always at least one large, well-defined nucleus. The spherical cells are only in contact with the other elements of the tissue, but the branching cells

* Fibres of Remak.

are well ascertained to be continuous by means of their prolongations, some with each other and some with tubular nerve fibres.

The free *nuclei* are very abundant throughout the gray matter of the cerebro-spinal axis. They are generally smaller than those contained within the cells and are supposed to be the germs of future nerve cells.

Fig. 18.



Large nerve cells from the anterior horns of the gray substance of the spinal cord, highly magnified.

The *granular matter* seems to be a kind of blastema or matrix in which the other elements are developed. It is to all appearances the same material as that within the cells. It is found only in the gray substance.

Chemical Composition.—The nervous system is remarkable for being the only tissue of the body in which phosphorus has been detected. It was first discovered by Vauquelin, and is stated by Couerbe to exist in combination with the fatty substances, of which he enumerates four varieties, distinguished by the names *cérébrote*, *stéaroconote*, *céphalote*, and *éléencéphol*. This chemist has also found that the proportion of phosphorus in the brains of idiots is less than in the brains of ordinary individuals. The great bulk of the brain, however, is water, holding albumen in solution. The following analysis of human brain is from Vauquelin:

Water	80·00
Albumen	7·00
White fat	4·55
Red fat	·70
Osmazome	1·12
Phosphorus	1·50
Acids, salts, and sulphur	5·13
	100·

Arrangement of the Nervous Elements in Different Parts of the System.—It only remains to present a brief outline of the arrangement of the preceding subdivisions and elements in the central and peripheral portions of the nervous system.

The **Cerebro-Spinal Axis**, the great centre of the animal system of nerves, is contained in the cranium and spinal canal, and is considered as divided into two corresponding parts, the spinal cord and the encephalon or brain. The latter comprises the medulla oblongata, cerebellum, and cerebrum. Each of these divisions is composed of gray and white substances, but in different proportions and differently arranged.

In the *spinal cord* the gray substance forms a central column or axis, surrounded on all sides by white substance, and extending from one end of the cord to the other. It is composed of delicate tubular nerve fibres, branching or multipolar cells, and numerous fine bloodvessels, but the relation of the special elements in man is not positively determined. Owsjannikow asserts that in the cord of fishes each cell has five prolongations, which are disposed as follows: "The most internal process, after it leaves the cell, enters the white commissure of the cord, and, traversing it, reaches the white substance of the opposite side, where it loses itself in another similar cell; this is the branch which establishes a route of connection between the two lateral masses of nerve cells of either side. The anterior process runs into the anterior, and the posterior into the posterior root, of each spinal nerve: and finally, the processes given off above and below become continuous with the longitudinal fibres of the cord."*

The white substance of the cord is much more abundant than the inclosed gray, and consists entirely of tubular fibres which are somewhat smaller than those of the nerves, and follow a longitudinal and horizontal direction. The horizontal fibres are continuous, upon the one hand, with some of the fibres forming the roots of the spinal nerves, and, upon the other, communicate with the cells of the gray substance, of which it is probable they are in a measure prolongations. The longitudinal fibres are far more abundant, and have been divided into two sets; one derived from the roots of the nerves and continued upward into the brain, and

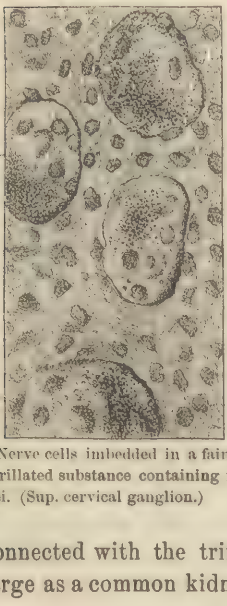
* Morel's General Anatomy.

the other limited to the cord, and extending from one part of its length to another, for the purpose of associating its different portions.

In the *brain*, the gray substance is found principally in two situations, viz., upon the surface of the organ, and in the bodies within, known as the primitive ganglia. In the former it constitutes a folded layer of two or three lines in thickness, called the cortical layer, which is in close contact with the large mass of white substance underneath, and invested externally by the vascular membrane called the pia mater, from which it receives numberless small bloodvessels. In the quadrigeminal bodies, beds of the optic nerves, and the other primitive ganglia, it forms depots, which seem to preside over the strictly animal functions of the body. The cortical layer consists (1) of branching cells which are continuous by their processes with each other and with nerve fibres; (2) a large number of spherical cells; (3) nerve fibres, some of which penetrate from below and terminate near the surface, while others cross each other in every direction, seemingly only to associate different parts; (4) an abundance of free nuclei; and (5) a soft granular matrix in which the other elements are imbedded.

The white or medullary substance constitutes by far the larger bulk of the encephalon. It is composed of the ordinary tubular or double contour fibres, of which two general classes are made according to their supposed functions: 1. The converging fibres, which comprise all those which simply pass from one side of the brain to the other, forming what are termed commissures; 2. Divergent fibres, which coming up from the spinal cord, diverge in all directions toward the under surface of the gray layer. But little further is known in regard to the disposition of the fibres, owing to the great difficulty of tracing the individual fibres, or even the fasciculi, through so great a mass of similar material.

Fig. 19.



Nerve cells imbedded in a faintly fibrillated substance containing nuclei. (Sup. cervical ganglion.)

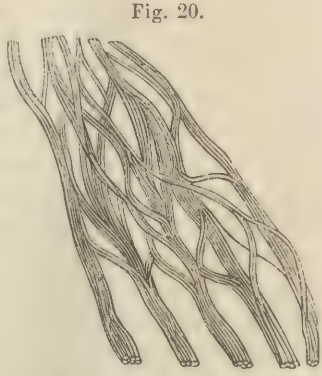
The *Ganglia*, as the term implies, are knots or swellings which are found in the course of certain nerves. They are found in the animal system of nerves as well as in the sympathetic, and are commonly considered to be independent depots or sources of power. They are generally oval or fusiform in shape, and vary in size from that of a small grain of wheat or millet seed to that of a pea. Some, however, as for instance the semilunar ganglia of the sympathetic system, and the ganglia of Gasser connected with the trifacial, are crescentic or triangular, and nearly as large as a common kidney bean. Their elementary parts are—1. A dense

grayish areolar investment, from the deep surface of which are given off numerous septa, dividing the organ into a great number of minute compartments. The fibres of these septa, sometimes denominated the stroma of the ganglion, seem to be continuous with the so-called gray fibres of the nerves, and are marked by similar oval nuclei imbedded in their structure. 2. Nerve cells (Fig. 19), generally bipolar, occupying the cavities, and continuous by their prolongations respectively with the fibres of the nerves which enter into and emerge from the organ. 3. Nerve fibres, many of which are connected with cells as just mentioned, while others pass through circuitously, but without interruption to their continuity.

The Nerves.—The peripheral portion of the nervous system consists of prolongations of the tubular fibres of the central masses, collected into bundles or fasciculi, and these again into larger cords, held together by areolar tissue, and inclosed by a common covering of the same tissue called the sheath. Gray fibres are also observed in some of the nerves, especially those of the sympathetic system, which have, in consequence, a pearly appearance, but, as already stated, these are probably only areolar fibres of a peculiar character. The smallest bundles of nerve fibres are scarcely visible to the naked eye, and their investment, although described as a continuation of the areolar sheath of the larger fasciculi, presents a homogeneous or structureless appearance under the microscope, and has been sometimes called the neurilemma; but this term is now more appropriately applied to the wall of the primitive fibre.

The branching of nerves, which takes place throughout every part of the body, is produced by the separation of bundles and fibres, but never by the division of a primitive fibre, except possibly at their terminations. Again, nerves communicate with each other by an interchange of bundles and of fibres, but never by a blending of one fibre with another. These interchanges are, in some places, so numerous and complicated as to form a kind of network or *plexus* (Fig. 20).

Fig. 20.



The axillary plexus of nerves.

Origin and Termination of Nerves.—The internal or central extremities of the nerves are termed their roots and origins, in distinction from their peripheral extremities, which are called terminations. These origins are said to be apparent and actual. Thus, the spinal nerves have an *apparent*

origin from the sides of the spinal cord; but their *actual* origin can be ascertained only by tracing out the minute fibres, partly in the brain, and partly in the adjacent gray substance of the cord. Our knowledge, however, upon these points is very imperfect.

The *terminations of nerves* are involved in almost as much doubt as their origins. It was once the prevailing opinion that the nerves have no terminations properly so called, but that the elementary fibres form loops with one another, and return to the centres, and this is undoubtedly

Fig. 21.

Ultimate anastomosis of a digital nerve.

Fig. 22.

Pacinian bodies attached to a digital nerve.

the case in some parts of the body (see Fig 21). Wagner supposes, however, that true terminations do occur; and this has been demonstrated in the nerves of the hand, whose fibres may be traced into little oval-shaped particles, called the *Pacinian bodies*, after Pacini, of Pisa, who first described them, about a century ago. These little organs (Fig. 22) are found in great numbers in the palms of the hands and soles of the feet, connected more particularly with the cutaneous branches of the nerves. They have been discovered also in other parts of the body, but in comparatively small numbers. Their size varies from $\frac{1}{15}$ to $\frac{1}{10}$ of an inch in length, and from $\frac{1}{26}$ to $\frac{1}{20}$ in breadth. They have a white or opaline appearance; and when divided and examined under the microscope, are found to be composed of numerous concentric laminæ (Fig. 23), one within another, inclosing at the centre a small cylindrical cavity filled with a transparent fluid. The nerve fibre enters this cavity at one extremity, and ends in a small bulbous enlargement near the other.

The *Sympathetic* or *Organic Nerves* consist of both tubular and gray fibres collected into fasciculi, and inclosed within a common sheath. The proportions of the two kinds vary, but in most of the nerves the gray predominate. The tubular or white fibres are finer than in the animal system, and are said to be offshoots from the spinal nerves. The gray fibres do not differ from those in other situations.

Fig. 23.

Structure of a Pacinian body. 1, the external laminæ, which are kept separated and distended by a fluid; 2, the inner series of laminæ lying in contact; 3, the nerve, which at 4 has penetrated all the laminæ, and terminates at 5 in a slight bulb; 6, the conical stalk or pedicle, deriving its external tunic from the sheath of a primary bundle; 7, a capillary artery, that enters the body and ramifies upon its laminæ.

EPITHELIAL TISSUE.

All the free surfaces of the body, both external and internal, are invested by a delicate transparent cellulo-membranous layer, which upon the skin is denominated *epidermis* or *cuticle*, and, upon the serous and mucous membranes, *epithelium*. In the former situation, it forms a thick horny coat for the protection of the subjacent sensitive tissue, but it may be readily separated by blistering, which causes a collection of water beneath it, and thus detaches its connections. In the latter, it is so thin that it can be stripped off only in limited fragments.

Structure.—Epithelial Tissue consists essentially of nucleated cells held together by a tenacious blastema, and is doubtless produced by a constant process of exudation from the surface upon which it is situated. It differs very greatly in thickness in different situations; the cells forming in some places several superimposed layers, and in others only a single thin pellicle. It is organized, although possessing neither vessels nor nerves; is rapidly reproduced when destroyed; and is, probably, always desquamating or wearing away at its free surface.

The difference in the shape, size, and disposition of the cells in different situations, has given rise to the division of the tissue into several varieties, all of which may be comprised under three principal heads: 1. Squamous epithelium; 2. Columnar epithelium; 3. Ciliated epithelium; to which a fourth is sometimes added, called the *spheroidal*.

Squamous, tesselated or **pavement epithelium**, as it is variously termed (Fig. 24), examined upon its free surface, consists of angular, flattened cells, connected together by a tough, intercellular matter, and presents somewhat the appearance of blocks in a mosaic pavement. In some situations, as upon the serous membranes and the inner surface of the heart and bloodvessels, they form but a single delicate layer or film; but upon the synovial membranes, the conjunctiva of the eye and some other mucous membranes (Fig. 25), and more particularly upon the skin,

Fig. 24.

Tesselated, pavement or squamous epithelium.

Fig. 25.

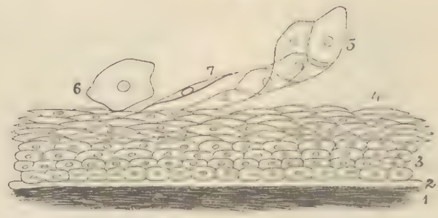


Diagram of a section of the mucous membrane of the mouth, highly magnified. 1, fibrous layer, in which the bloodvessels are distributed; 2, basement layer; 3, young cells of the epithelium; 4, older cells transformed into scales; 5, shred of epithelium cast off; 6, a single scale, seen on its broad surface; 7, a similar scale, seen in its thickness.

constituting here the cuticle or epidermis, it can be readily shown to consist of several strata. In this stratified variety, the cells present different appearances at different depths, owing to certain changes which they undergo as they proceed toward the surface. If a vertical section of cuticle, taken from the palm of the hand or sole of the foot, be examined with a lens, the cells lying next the true skin will be seen to be vertically oval, distinctly nucleated, and imbedded in a clear, transparent, granular blastema; a little farther removed, they are spherical but somewhat larger, and seem to be filled with a semifluid matter surrounding the nucleus, and the blastema appears of a more tenacious, viscid consistence; still nearer the surface they are spread out or flattened, have a dry opaque appearance, and are much more firmly adherent to each other; and finally, along the line of the free surface, they present the appearance of a confused mass of undefined dry scales of a dull white color. In this last condition, they are continually falling off, while those below are continually pressing outward to take their places.

In addition to those already mentioned, squamous or pavement epithelium is found in the following localities, viz.: upon the lining membrane of the tympanum, petrous cavities, mouth, lower half of pharynx, œsophagus, air vesicles of the lungs, excretory ducts of kidneys and liver, female genital organs as high as the cervico-uterine orifice, internal

surface of sclerotic and cornea and outer surface of choroid coat of the eye, margins of the eyelids, nose, and anus.

Columnar or cylinder epithelium (Fig. 26) is made up of elongated cells set closely parallel to each other and vertical to the surface upon which they rest. They are commonly of a hexagonal outline but pointed below, are of uniform size in the same specimen, and have large oval nuclei near their centres. Their conical extremities are imbedded in a blastema filled with new cells in different states of development; but their large ends are free, and, when looked at perpendicularly, present a tesselated appearance.

Fig. 26.

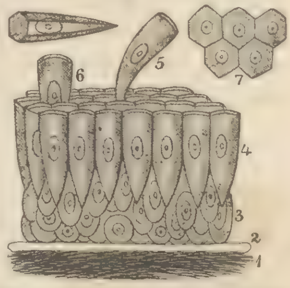


Diagram of a vertical section of mucous membrane of the small intestines, highly magnified. 1, fibrous layer, in which the bloodvessels are distributed; 2, basement membrane; 3, young nucleated cells; 4, layer of columnar cells; 5, 6, cells in the act of being shed or thrown off; 7, free ends of the columnar cells, exhibiting their six-sided form 8, a single columnar cell, exhibiting its actual form at all parts.

This variety of epithelium is found upon the mucous membrane of the stomach, small and large intestine, tubular intestinal glands, gall-bladder, and urethra.

Ciliated epithelium consists of columnar cells arranged like the preceding, but presenting upon their free extremities numberless minute hairlike processes called cilĭa, which are endowed with a peculiar vibratory movement. This motion is uniform and wavelike, and does not cease immediately at death, and may therefore be readily witnessed in a fresh specimen. Under these circumstances the cilia may be seen swaying to and fro like a field of young wheat moved by a gentle wind, and if a little fine powder be sprinkled upon the surface, the particles will be carried gradually along in the direction of the waving, and finally thrown off at the edge of the specimen.

Fig. 27.

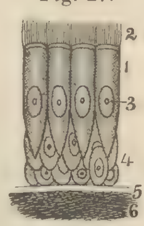


Diagram of a vertical section of the bronchial mucous membrane, highly magnified. 1, columnar ciliated epithelial cells; 2, cilia; 3, nuclei; 4, young cells; 5, basement membrane; 6, fibrous layer.

The use of ciliary motion is to convey fluids uniformly along certain cavities and tubes, as for instance the mucus of the nose toward its outlets. Its nature or source is yet involved in doubt. Sharpey supposes it to result from inherent contractility; others from a species of erection of the cilia; and others still to the contraction of muscular fibres attached to their bases.

Ciliated epithelium is found upon the mucous membrane of the nasal cavities, upper part of the pharynx, Eustachian tube, larynx, trachea, bronchi, uterus, and Fallopian tubes.

PIGMENTARY TISSUE.

The black color of the choroid coat of the eye and the skin of the negro, and the various shades of brown presented by other races of mankind, and the dusky hue of the scrotum, nipple, and some parts of the body of the white races, are due to a peculiar coloring matter called black pigment. In the choroid membrane, the coloring matter is contained in special cells, which are quite large, hexagonal, and arranged like the pavement epithelial cells. They consist of a delicate homogeneous membrane, inclosing a transparent nucleus and the dark material in question. The latter is insoluble in cold and hot water, alcohol, ether, and the volatile oils; and on chemical analysis yields carbon, hydrogen, nitrogen, and oxygen, and a small quantity of oxide of iron, common salt, and phosphate of lime.

Fig. 28.

Black pigment cells, magnified 410 diameters. *a*, *b*, nuclei.

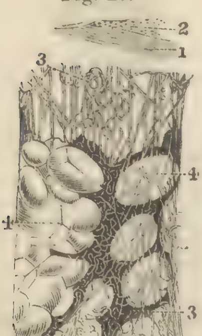
The coloring matter of the skin, however, is not contained in separate cells, but in the deep cells of the epidermis lying next to the corium or true skin.

ADIPOSE TISSUE.

Adipose Tissue or the fat is one of the simplest structures in the body. It consists of tolerably large cells or vesicles containing a nucleus adherent to the walls of the latter and a semifluid oily substance which becomes solid after death.

The adipose vesicles are commonly collected into lobules, and these again into masses of various size; are sometimes observed to be oval in shape and sometimes polyhedral; measure from $\frac{1}{300}$ to $\frac{1}{800}$ of an inch in diameter; and, when examined by transmitted light, present a clear opaline tint exteriorly, and a cloudy white appearance within. They are lodged in the meshes of the areolar tissue by which they are held in position and prevented from gravitating toward the dependent parts of the body. The contained oily substance is inodorous, of a pale yellowish tint, possesses a faint sweetish taste, and soon becomes rancid when exposed to the air at a warm temperature. Its different consistence in different animals depends upon the different proportions of stearin and olein of which it consists.

Fig. 29.



Fat cells lodged in areolar tissue. 1, fasciculus of areolar tissue; 2, same in a more amorphous state; 3, 3, white and yellow fibres of areolar tissue; 4, 4, adipose cells or vesicles.

The quantity of adipose tissue in the human body is subject to great diversity, being almost entirely wanting in some individuals, and so excessive in others as to constitute a disease. It usually abounds in the subcutaneous areolar tissue of the abdomen, pubes, buttocks, face, and armpits, in the orbits, upon the heart, around the kidneys, beneath the skin of the palms of the hands and soles of the feet, and in the medullary canals of the long bones. It is never found in the cavity of the cranium, on the surface of the lungs, beneath mucous membranes, or in the areolar tissue of the eyelids, scrotum, or penis.

The uses of the adipose tissue are various. Beneath the skin, it assists in retaining the heat of the body; it surrounds and facilitates the motion of the joints; by filling out the intermuscular spaces of the face and neck, it gives to the features the rounded lines of beauty; its presence in the centres of the bones increases their solidity and elasticity; and lastly, wherever situated, it serves as nutriment in reserve, to be taken up and used by the system, when, from disease or other causes, the usual means of supply is wanting.

MUSCULAR TISSUE.

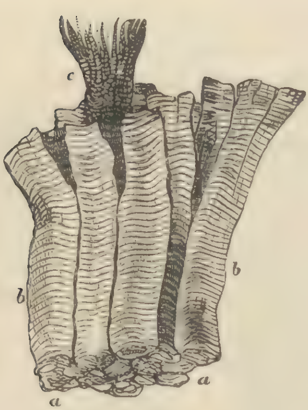
The Muscles, constituting what is commonly termed the flesh of animals, are the instruments by which the active movements of the body are effected. For this purpose they are endowed with a special vital property termed contractility or irritability. In many of the muscles—those, for instance, of locomotion, respiration, and the movements of the organs of sense—this property is to a certain extent under the control of the will, and they are denominated on that account voluntary muscles. On the other hand, the muscular coat of the hollow organs, as the stomach, intestines, bladder, etc., are entirely beyond this influence, and are called therefore involuntary muscles. Under these two varieties is comprised all the muscular tissue of the body; but that of the heart, as will hereafter be seen, partakes of the characters of both.

Voluntary Muscles.—The voluntary muscles, or, as they are frequently called, the muscles of animal life, are separate and distinct organs, all composed, however, of the same elementary parts. Their bright red color, fibrous texture, and well-defined outline are familiar to every one. Their number in the human subject is variously estimated at from three to four hundred. They are all in pairs, corresponding to the two lateral divisions of the body, or, where this is not strictly true, they consist of two symmetrical halves. In the extremities they are generally elongated in a common direction, and are provided with rounded or flattened tendons, by which they are attached to the bones. On the trunk they are usually in the form of broad layers, with numerous attachments, and their tendons possessing the same membranous disposition are here called aponeuroses.

Structure.—Voluntary muscular tissue presents to the naked eye a collection of red parallel fibrous bands, of an angular or prismatic outline, varying very greatly in size in different situations, and held more or less closely together by thin intervening layers of areolar tissue, continuous externally with a denser membrane of the same material which forms the common investment or sheath of the muscle. These are called *secondary fasciculi* or bundles, which, upon closer examination, are found to be composed of smaller bundles possessing the same general characters and known as the *primary fasciculi.* The latter are also provided with separate envelopes of areolar tissue continuous with those of the former, and by the use of a microscope, of even a low power, may be readily resolved into smaller threads or fibres.

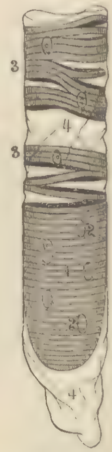
The *fibres* extend the entire length of the fasciculus, have a prismatic outline, are moderately translucent, and measure about $\frac{1}{400}$ of an inch in diameter. They each possess a delicate homogeneous investment called the *sarcolemma* or *myolemma*, and are marked by numerous transverse

Fig. 30.



A few muscular fibres, being part of a small fasciculus, highly magnified, showing the transverse striæ. *a*, end view of *b*, *b*, fibres; *c*, a fibre split into its fibrillæ.

Fig. 31.

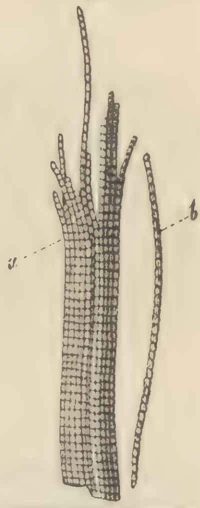


A muscular fibre of a salamander, a batrachian reptile, which had been long kept in weak alcohol. 1, muscular substance; 2, nuclei; 3, muscular substance split into disks; 4, the myolemma.

lines or striæ, from which latter circumstance they are frequently designated striated or striped muscular fibres, to distinguish them from organic muscular fibres, which are unstriped. In the manipulation necessary for their examination, they often break transversely in the situation of the striæ, and then present the appearance of a series of superimposed plates or disks, as represented in Fig. 31. More minute analysis shows them to consist of still more minute filaments termed fibrillæ.

The *fibrillæ* or primitive fibres (Fig. 32) are not less than $\frac{1}{12000}$ or $\frac{1}{15000}$ of an inch in diameter, and seem to be composed of exceedingly small polygonal particles, disposed in longitudinal series or rows, which give them a peculiar beaded appearance.

Fig. 32.



Fibrils from a muscular fibre of the axolotl, a batrachian reptile; highly magnified. *a*, bundle of fibrils; *b*, an isolated fibril.

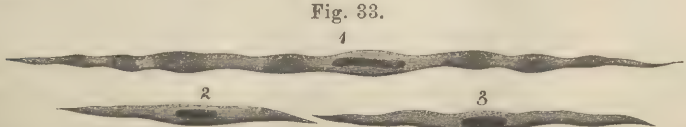
The muscles are largely supplied with arteries, veins, and nerves. The arteries and veins ramify between the fasciculi, where they form capillary plexuses which penetrate as far as the fibres, but have never been traced into the sarcolemma. The nerves belong principally to the motor division of the cerebro-spinal system, but their mode of termination is a disputed question, some anatomists contending that the nerve fibres anastomose with each other by forming loops transversely to the muscular fibres, and others that they penetrate the sarcolemma and end in the substance of the fibres.

Most of the muscles are provided with *tendons* or sinews, by which they are attached to the bones. These are of an entirely different structure, belonging to the class of fibrous tissues, and are united to the former by becoming continuous with areolar tissue forming the sheaths of the fasciculi.

Involuntary Muscles.—The muscular tissue of organic life performs those movements of the body that are entirely beyond the control of the will. It is abundant, therefore, in the walls of the œsophagus, stomach, small and large intestines, the bladder and pregnant uterus, and in smaller quantities in the trachea, bronchial tubes, ureters, hepatic and pancreatic ducts, seminal vesicles, deferential tube, and the middle coat of the blood-vessels and lymphatics. It is also found in greater or less abundance in the skin throughout all parts of the body, where, by its contraction, it gives rise to the peculiar appearance denominated goose-flesh.

It is readily distinguished from the animal variety by its pale yellowish or grayish hue, its lack of any attachment to the skeleton, the scattered

Fig. 33.

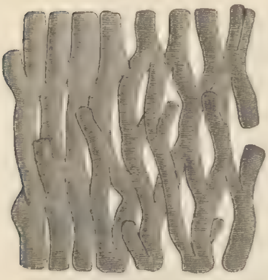


Unstriated muscular fibre. 1, from the small intestine; 2, from the middle coat of an artery; 3, from a vein.

irregular arrangement of its fibres, and the absence of tendinous terminations. Its ultimate fibres (Fig. 33) are fusiform or spindle-shaped, about

$\frac{1}{2000}$ of an inch in diameter, nucleated at the centre, and marked by a series of enlargements and contractions which give to their exterior a wavy appearance. Being devoid of transverse markings, they are commonly called unstriped muscular fibres. Their structure is homogeneous or obscurely granular. Like the striated variety they are, in many situations, collected into fasciculi held together by areolar tissue, but unlike the former they never constitute defined masses or organs. In the skin they are mingled indiscriminately with the other elements of this tissue.

Fig. 34.



Striated muscular tissue of the heart, highly magnified.

The muscular fibres of the heart, although strictly involuntary in their function, approximate very nearly in structure to the voluntary variety. Thus, they possess the red color and transverse markings of the latter, but are not collected into fasciculi, and present the peculiarity of anastomosing, as exhibited in the accompanying drawing (Fig. 34), after Leidy.

FIBROUS TISSUE.

The Fibrous Tissue is found in great abundance in different parts of the body, subserving a variety of purposes, nearly all of which are entirely mechanical. It is characterized by a brilliant white or pearly color, great strength, perfect pliability, an almost entire want of elasticity or extensibility, and a very low grade of vitality. Examined closely with the naked eye, it is seen to consist of small shining threads or fibres, which in some situations are parallel, and sometimes cross each other in every direction. Analyzed with the microscope, these so-called fibres are found to be bundles of still smaller filaments, which are precisely similar to those of areolar tissue. Indeed, these two tissues constitute properly but one system, and are distinguished only by differences in the closeness of the arrangement of their ultimate fibres. Hence the discrepancies among anatomists in regard to the classification of certain structures that belong to one or other of these divisions; what is denominated areolar by some being called fibrous by others, and conversely.

The forms of the different fibrous structures, and the names by which they are known, vary in different situations. Around the joints, where this tissue binds the opposed bones together, the fibres are parallel and are collected into funiculi or cords, called ligaments; upon the muscles of the extremities, it is spread out into membranes denominated fasciæ or aponeuroses; at the ends of the muscles, it is the medium of attachment between them and the bones, and is called tendon, which may be either

cordlike or membranous. It forms also a closely investing membrane for the bones, called periosteum, and lastly membranous coverings for several of the organs, *e.g.* the dura mater, the proper tunic of the testis, etc. In consequence of the low vitality of this tissue, when it is attacked with acute inflammation, it soon passes into a state of mortification. When punctured, cut, or subjected to the action of chemical irritants in the living animal, no evidences of sensibility are observed, but when violently twisted or stretched, as in severe sprains, the most acute pain is often experienced. Whether this pain is produced by the injury to the ligaments themselves, or to that of contiguous nerves, is an unsettled question.

The proper bloodvessels of fibrous tissue can be seen only with a magnifying-glass; they are very small and much scattered, except in the periosteum and dura mater, in which there are numerous arteries and veins; but in these cases the vessels simply traverse the tissue in order to reach other parts. In consequence of this difference in vascularity, the fibrous tissues are considered as divisible into two classes, the vascular and non-vascular, the former comprising the periosteum, pia mater, capsule of Glisson, etc., which serve as nutrient membranes to the structures which they inclose.

YELLOW ELASTIC TISSUE.

The Yellow Elastic Tissue is analogous to the preceding, but differs from it in several important particulars, the most remarkable of which are its great extensibility and elasticity. It is employed in the animal economy, when continued or frequently intermitting support or resistance is required, and, in many situations, it serves at the same time as ligament, and sometimes as envelope to certain organs. It is largely developed in the back of the neck of quadrupeds, where it is called the nucha ligament (ligamentum nuchæ), or, by the common people, whitleather. In the human subject, it is found as a separate tissue, principally between the arches of the vertebræ, and in the trachea, bronchial tubes, bloodvessels, and scrotum. In other situations, it is largely mixed with areolar tissue, as in the true skin, beneath the serous membranes, and in the external coats of the arteries and veins.

Fig. 35.

Yellow elastic tissue.

To the naked eye, the yellow elastic tissue presents the appearance of longitudinal, parallel fasciculi, of a dull yellowish color, and a rather rough or flocculent surface. Under the microscope, these fasciculi are resolved into well-defined transparent fibres (Fig. 35), which, traced out, are found to have a serpentine course, and soon divide into branches, that form a kind of network between the larger trunks. They have also been noticed to possess a peculiar tendency to curl up at the blunt ends. Their

size varies greatly, some of the larger trunks measuring as much as $\frac{1}{4000}$ of an inch, while many of the smaller branches do not exceed $\frac{1}{22000}$.

Yellow elastic tissue long resists the action of boiling water, but, like fibrous and areolar tissue, is ultimately converted into gelatin The acids and alkalies have little or no effect upon it. In alcohol, it retains its extensibility and elasticity for an unlimited time. No nerves have ever been traced into this structure, and, as far as we know, it possesses no sensibility whatever. Its fibres are not endowed with vital contractility, but they frequently exist in conjunction with true involuntary muscular fibres, as in the middle coat of the arteries. Its bloodvessels are few, small, and scattered, as in the fibrous tissue.

CARTILAGINOUS TISSUE.

Cartilage enters very largely into the structure of the human body, especially in its growing state, forming the matrix in which ossific matter is deposited in the development of the skeleton, and coverings for the surfaces of bones in the composition of the joints. That portion which in the growth of the individual is transformed into bone, is sometimes denominated temporary cartilage, to distinguish it from the permanent, which generally remains unchanged throughout life, although in advanced age the latter also often becomes the seat of ossific deposits. A more important division is that into cartilage and fibro-cartilage.

Cartilage does not possess precisely the same properties in all parts of the body. It is generally a very dense elastic substance, of an opaque white color, variously tinged with blue, grating under the knife, and, when freshly cut, presents the appearance of an amorphous, hyaline matter, in a state of great condensation. Exposed to the weather it resists putrefaction for a long time. On exposure to heat it loses about three-fifths of its weight by the evaporation of its watery parts, becomes hard and crisp, much diminished in volume, semitransparent, and of a yellowish-brown color. By boiling for twelve or eighteen hours, it is converted into a clear, jelly-like substance called *chondrin*, which, unlike ordinary gelatin, is soluble in alcohol, and is precipitated from its solutions by alum, acetic acid, acetate of lead, and sulphate of iron.

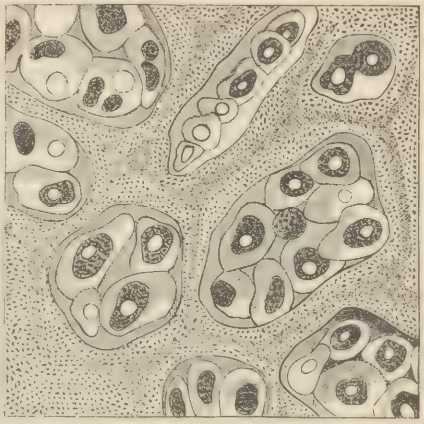
The density, toughness, and great elasticity of cartilage eminently fit it for the uses to which it is put in the animal economy. Thus it furnishes the ends of the bones with a tough but yielding covering, where they are opposed in the movable joints; it extends between the sternum and the ends of the ribs, maintaining the form of the latter, but not their rigidity; it constitutes the several cartilages of the larynx, except the epiglottis, the rings of the trachea and bronchial tubes, and the cartilages of the nose.

STRUCTURE.—Under the microscope, cartilaginous tissue is found to consist of a structureless matrix containing numerous cavities lined by a membrane, and inclosing nucleated cells.

The *matrix* or fundamental substance* is a dense, opaline, amorphous material, possessing a faintly granular appearance, but in pure cartilage entirely devoid of fibrous arrangement.

The *cartilage cells* are usually seen in groups contained in cavities lined by a structureless membrane continuous by its outer surface with the intercellular matrix. In the deeper parts of the cartilages the cavities are large, well defined, and of an oval figure, but near the free surfaces they are flattened and parallel to the latter. The cells vary in number from one to ten or fifteen in each cavity, have a distinct nucleus, and often contain oil globules.

Fig. 36.



A transverse section of a cartilage of a rib, magnified 350 diameters, showing the parent cartilage cells in groups. (Hassall.)

Fibro-Cartilage differs from true cartilage mainly in the character of its matrix, which is distinctly fibrous, the fibres winding around and between the groups of cells, and crossing each other in every direction. It includes the cartilages of the external ear, Eustachian tube, epiglottis, intervertebral disks, and interarticular cartilages.

All the cartilages except the articular are invested by a nutrient membrane called the *perichondrium.* This consists of an interlacement of connective fibres and capillary bloodvessels, mingled with which may be seen numerous plasmatic cells. Except in the case of the costal cartilages, no bloodvessels penetrate below the surface, and the precise manner in which the growth of the tissue takes place is not determined. Being entirely devoid of nerves, they possess no sensibility whatever.

When once destroyed, either mechanically or by ulcerative action, cartilage is never reproduced. If fractured, an accident that sometimes happens to the costal cartilages, reunion takes place by the deposit of a fibrous substance produced by a transformation of the plasmatic cells of the perichondrium; or, sometimes, instead of this intervening fibrous tissue, a bony clamp surrounds the broken extremities.

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* Morel.

OSSEOUS TISSUE.

The Osseous System consists of a large number of separate pieces called bones, which united constitute the skeleton or framework of the body.

The bones are distinguished from all other organs by their almost stony hardness, yellowish-white color, the slight degree to which they can be flexed and extended, and their entire want of sensibility. They form a basis of support for all the soft parts, shielding many that are delicately organized, and serve as levers by which the muscles perform the various movements of the body.

In reference to their form, the bones are divided into three classes—the long, the broad, and the short; to which a fourth is sometimes added called the mixed, or, by Quain, the complex bones.

The *long* bones are situated for the most part in the extremities. Each of them has a shaft or body, which is nearly always an irregular three-sided prism, and two expanded extremities that serve for the formation of joints, the attachment of ligaments, and the reflection of tendons. The length and breadth of the *broad* bones are nearly equal, and much greater than their thickness; they are intended principally for the formation of cavities, and are much less numerous than either of the two other varieties. The three dimensions of the *short* bones are nearly equal, but their contour is generally very irregular. They are found where great strength and slight motion are required, as in the spinal column, tarsus, and carpus. The *mixed* bones partake of the distinguishing characters of the three preceding classes, but most nearly resemble the last.

In studying the external characters of the bones, many points must be considered besides their general form. They present numerous prominences and depressions, ridges, fissures, etc.; some of which may be briefly designated here.

EMINENCES.—The older anatomists classed all the bony prominences or processes under two heads, *apophyses* and *epiphyses*. The former comprised all those projections produced by a prolongation of the bone, and the latter all that were known to be developed separately, and afterward united to the main portion or body. Another and far better distinction into articular and non-articular prominences is now generally adopted.

The *articular* eminences, so called because they are essential parts of articulations or joints, are smooth and well defined, and, in the recent state, covered with cartilage. Their shape and size differ materially in different situations, but in the corresponding bones of different individuals they are nearly alike. Their special names, when they have any, are usually derived from their outline. Thus, a spherical outline constitutes a head, which is called a condyle when flattened upon two opposite sides, etc.

The *non-articular* processes or eminences are rough and irregular, and principally designed for the insertion of muscles. They are known by a variety of names. When large, uneven, and somewhat rounded, they are called tuberosities; when smaller, tubercles; when slender, sharp, and small, the name spinous process is applied; when elongated upon the surface of the bone, presenting an irregular free edge, they are denominated crests or ridges, and sometimes lines. Some have received names from their fancied resemblance to certain objects: *e.g.* zygomatic (like a yoke), styloid (like a style), odontoid (like a tooth), etc.

Depressions.—The depressions or excavations found upon the surfaces of bones are intended either for articulation or the insertion of muscles and ligaments. Their shape and size, and the names by which they are known, are exceedingly various, and forbid any general classification. Thus, the excavation upon the innominate bone, for the articulation of the head of the femur, is deep and hemispherical, and is called the cotyloid* cavity; the sockets of the teeth are named alveoli,† etc. Many articular cavities are superficial, and to these the term glenoid is applied. Fossæ are shallow excavations of various sizes; sinuses are cavities with a narrow entrance; furrows or grooves are superficial excavations, whose names sufficiently indicate their form.

Foramina.—Most of the foramina found upon the surface of the bones are intended for the transmission of bloodvessels. Three kinds are usually enumerated.

1. The external surface of every bone will be found on examination to be perforated by thousands of minute openings, leading into the substance of the tissue. They all contain arteries and veins, particularly the former, which pass to and from the periosteum. They must not, however, be confounded with the little pits, which also exist in the same situation, and receive fibrous prolongations of the periosteum.

2. Each bone has what is called a nutritious foramen, through which its principal artery is transmitted. In the long bones, this foramen is situated in the shaft, generally nearer the superior than the inferior extremity. In the broad bones, it exists on one of the flat surfaces, and in the short it has no regular position. Some bones have two foramina of this kind.

3. The extremities of the long bones just beyond their articular surfaces, the adjacent parts of the circumference of the broad, and the bodies of the short bones present numerous large foramina, many of which are almost as large as the nutritious foramina. These are intended chiefly for the transmission of veins.

The osseous tissue is by far the heaviest in the body; but in the short

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* Like a cup. † Like the cells of honeycomb.

bones and the extremities of the long ones, it incloses numerous large areolæ or cavities, which render these parts comparatively light. In the shafts of the long bones, and the external crust of the short bones, these areolæ are small, and the tissue dense and hard.

CHEMICAL COMPOSITION.—Without its investing membrane, and its contained water and fat, bone is found to consist of two distinct parts: the organic or animal, and the inorganic or earthy. To obtain these parts in a separate state two processes are necessary: 1. By macerating a bone for some days in dilute hydrochloric acid, the earthy matters may be dissolved out, leaving a tough, elastic, flexible substance bearing the shape and size of the original piece. This is the *animal* or *organic* part; or, as it is sometimes called, the bone cartilage. 2. By long and careful burning the animal matter may be consumed, leaving the *earthy* or *inorganic* part as an opaque white substance, which possesses the original form of the bone, but crumbles to powder under slight pressure.

In the bones of the adult, the proportion of earthy to animal constituents is about two to one. In young subjects, the proportion of animal substance is greater, and in old persons less. The subjoined table of the analysis by Berzelius shows the exact proportion of the two, and the composition of the earthy substance, which will be seen to consist almost entirely of phosphate and carbonate of lime:

		Berzelius.
1. Organic or animal matter		33·30
2. Inorganic or earthy constituent.	Phosphate of lime	51·04
	Carbonate of lime	11·30
	Fluoride of calcium	2·00
	Phosphate of magnesia	1·16
	Soda and chloride of sodium	1·20

STRUCTURE.—Under an ordinary magnifying-glass, or even, in the fœtal skeleton, to the naked eye, the external surface of the bones presents the appearance of compactly arranged fibres, which are longitudinal and parallel in the shafts of the long bones; in the broad, diverge from the centre toward the circumference; and in the extremities of the former and the bodies of the short bones are disposed in an irregular manner. To demonstrate these fibres, it is only necessary to remove the earthy substance, when, by bruising the extremity of the remaining animal substance, or by means of a pin or needle, they may be separated from each other to a considerable extent. At the same time, it will be found that the fibres form superimposed lamellæ or plates, which are connected by short bony filaments passing obliquely from one to another. This arrangement is also sometimes beautifully seen in bones that have been exposed to the weather; under these circumstances, there occurs an exfoliation or detachment of the layers successively from without inward.

The number and disposition of the laminæ vary in the different classes of bones, and in different parts of the same bone. In the shafts of the long bones, they are numerous and concentric; while in the short and broad varieties, and in the extremities of the long bones, there is often but a single layer, which forms the external crust or shell.

If a bone be carefully divided with a saw, the section will also present a fibrous appearance. In the shafts of the long bones and the crust of their extremities, and in the crust of the broad and short bones, these fibres seem to be close and compact, while in other situations, as in the interior of the broad and short, and extremities of the long bones, they form a loose open texture, whose interstices or areolæ are often very large. Based upon this difference in density, two kinds of tissue have been recognized by anatomists, the *compact* and the *spongy;* but, as correctly affirmed by Cruveilhier, there is properly but one form of structure, the *areolar*, which presents itself in some situations in a dense or compact, and in others in an open spongy form, the two varieties insensibly blending into each other. Areolæ exist, therefore, in all parts of the bones, and their size and shape depend upon the arrangement of the bony fibres and lamellæ. Whatever their size, they all communicate in the same bone, and in the spongy tissue, at least, are lined by a delicate vascular membrane that secretes the fatty matter with which, in the fresh adult bone, they are nearly always filled.

Such are the general characters of osseous tissue as seen with the naked eye or through a simple lens. The microscopic characters are equally interesting.

Microscopic Appearances.—If a thin transverse section of a long bone be examined by transmitted light, with a magnifying power of from three to six or eight hundred diameters, several dark circular or oval spots will be seen, surrounded by numerous concentric lines; and, at short intervals upon the latter, minute black specks, with other lines leading off from them in different directions. The large spots are the cut extremities of capillary vessels, called, after their discoverer, the Haversian canals; the concentric lines indicate the delicate concentric laminæ of bone surrounding these canals; and the small specks are little cavities called lacunæ, situated between the laminæ, and communicating with each other by minute canaliculi, which are shown by the crooked lines.

The *Haversian canals* (Fig. 37) are very numerous, particularly in the compact portion of bones, and they are remarkable for their short and tortuous course. Their diameter varies from $\frac{1}{1000}$ to $\frac{1}{200}$ of an inch. They communicate freely with each other, and, in the fresh state, are occupied by the small bloodvessels that ramify throughout every part of the tissue. The most superficial are generally very small, and open upon the surface by pores, through which the vessels from the periosteum are re-

ceived. The deep seated are larger, and, in the long bones, often communicate with the medullary canal,* probably for the purpose of transmitting vessels from the vascular membrane that surrounds the marrow.

Fig. 37.

A. Transverse section of a bone (ulna) deprived of its earth by acid. The openings of the Haversian canals seen. Natural size. A small portion is shaded, to indicate the part magnified in Fig. B.

B. Part of the section A magnified 20 diameters. The lines indicating the concentric lamellæ are seen, and among them the corpuscles or lacunæ appear as little dark specks. The foramina are the cut extremities of the Haversian canals.

The *concentric laminæ* surround the Haversian canals, and follow the same crooked course. This may be proved by examining a longitudinal or oblique section of a canal, when it will be seen that the lines run parallel with it, in the former case, and, in the latter, form ellipses around its extremity instead of circles, as when cut transversely. Their number around any one canal varies from one to six or eight, being generally greater in the compact than in the spongy tissue. They are exceedingly thin, and are said to consist of minute transparent fibres arranged in two sets, the fibres of each set running parallel but crossing the others obliquely (Fig. 37).

The *lacunæ* (Figs. 38, 39, 40), or, as they are often improperly termed,

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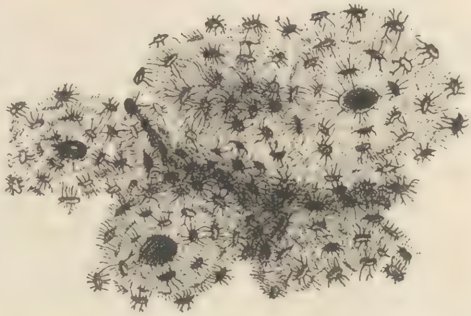
* Quain.

the bone corpuscles, are little recesses in the bone,* situated in great numbers between the laminæ, through which they communicate by means of their tubular prolongations called canaliculi. The shape of the lacunæ is that of an oval, flattened, as it were, between the laminæ; hence, when divided in any direction, they present the elongated fusiform outline represented in the figure.

Fig. 38.



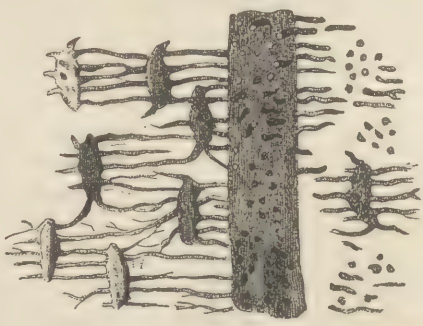
Transverse section of the Haversian canal and lacunæ.

The *canaliculi* pass off from the lacunæ in every direction, and, as just mentioned, form numerous anastomoses both between and through the laminæ; they thus maintain a free communication in every part of the bone. Since those nearest the Haversian canals open into them (Fig. 40), both lacunæ and canali-

Fig. 39.

Lacunæ, with their connecting tubuli or canaliculi.

Fig. 40.



Haversian canal, lacunæ, and canaliculi.

culi may be considered as appendages to the vascular canals, and are intended, in all probability, for the transmission of fluids to and from those portions of the tissue too minute to be reached by ordinary vessels.

Periosteum.—All of the bones are covered throughout, except where they are incrusted with cartilage, by a strong fibro-vascular membrane called the periosteum, which is quite thick in the young subject, and easily dissected off, but in advanced life becomes intimately blended with

* To prove that these lacunæ are really cavities, it is only necessary to examine the section upon a dark background by direct light, and drop upon it a little colored fluid of some sort, when the latter will be seen to enter the lacunæ and pass from one to another through the canaliculi.

the osseous tissue. It consists essentially of fine anastomosing bloodvessels, especially arteries, areolar fibres, and star-shaped or branching plasmatic cells. The bloodvessels, after dividing minutely, enter the bone substance through the little foramina which abound upon the surface of the latter, and form the capillary network known as the Haversian canals. The fibres belong principally to the white variety, and interlace in every direction. The plasmatic cells are most abundant in the deeper parts of the membrane, and here bear a close resemblance to the bone lacunæ, into which indeed they are supposed to be gradually transformed.

The periosteum is therefore very properly considered the nutrient membrane of bones ; and not only does it supply the latter with vessels, but it also secretes the superficial layers of osseous tissue. It is therefore a most important agent in the reproduction of bone, when this has been removed by disease or the hand of the surgeon.

Special Characters of the Different Classes of Bones. *Long Bones.* —The arrangement of the two kinds of tissue in the long bones, although several times adverted to in the foregoing pages, requires a separate notice. In order to be seen, one of the bones of the extremities, the femur, for example, should be carefully divided in a longitudinal direction, when it will be observed that the shaft is composed entirely of compact tissue, forming a hollow cylinder, whose cavity is called the *medullary canal.* This canal is largest at the middle of the bone, from which point it gradually narrows in both directions to its terminations in the spongy or cancellated tissue. The internal surface of its walls is rough, and, at its two extremities, the interlacing of the bony fibres and laminæ presents a beautiful reticulated arrangement, whose interstices are large and continuous with the areolæ of the spongy tissue. In the recent state, the canal is lined by a delicate vascular membrane, named the medullary membrane or endosteum, which secretes the medulla or marrow that fills the cavity, and furnishes nutriment to the surrounding osseous tissue. The vessels of this membrane enter and emerge at the nutritious foramen.

The object of the medullary canal is to give greater size and strength to the bone without a corresponding increase of weight, according to a well-known law in mechanics, that the same amount of material in the form of a hollow cylinder is stronger than when in the solid form. The contained medulla does not, therefore, properly constitute any part of the bone ; but is, in some measure, only an accidental constituent. It is entirely wanting in the wing bones of large birds, where, great lightness being required, the cavity contains nothing but air.

The extremities of the long bones are entirely spongy, with the exception of a thin layer of compact tissue that forms their external crust or shell. The areolæ are large, and communicate freely with each other, and with the medullary canal. They are also lined with a thin vascular membrane, and filled with an oily substance similar to the marrow.

Although much larger, the extremities of a long bone do not contain more osseous tissue than the shaft. Two sections of the same length, taken from the shaft and the extremity, have precisely the same weight. The increased size of the latter depends entirely upon its more open texture.

Broad Bones.—The broad bones consist of two compact layers or tables inclosing the cancellated or spongy tissue, which, in the bones of the cranium, is known under the name of diploë. The disposition of the two tissues, however, does not materially differ from that of the long bones. The compact tissue is thickest at the centre where the bone itself is thinnest, and the spongy tissue almost or entirely wanting; but near the circumference, where the bone is thick, a thin compact crust incloses a considerable amount of spongy tissue.

Short Bones.—The short bones are similar in every respect to the extremities of the long bones. They have a thin external layer of compact substance and spongy tissue within, whose cells are lined by a delicate vascular membrane, and filled with medullary matter.

Fig. 41.

Longitudinal section of the thigh bone. *a*, medullary canal; *b*, compact tissue; *c*, cancellate or spongy tissue; *d*, reticulate appearance of the spongy tissue.

The *Arteries* of the bones are small but numerous. The largest, called the nutritious arteries, enter the nutritious foramina, and are principally distributed to the endosteum. The others enter the small openings found upon every part of the surface, and a few traverse the large foramina around the extremities of the long and the circumference of the broad bones.

The *Veins* are large and numerous, and generally follow the course of the arteries; but in some instances, as in the cranial bones and bodies of the vertebræ, they constitute large tortuous canals or sinuses.

Lymphatics have never been demonstrated in the bones, but there is no doubt whatever of their existence. The impossibility of injecting them in opposition to their valves very readily accounts for their not having been seen.

Nerves from the cerebro-spinal system have been traced as far as the nutritious foramina, and some anatomists affirm that they have followed them into the interior of the bones. If it be true that the endosteum or medullary membrane possesses sensibility, as stated by Duverney, Bichat, Wistar, and others, there can be no doubt of their presence there.

Development of Bone.—Osteogeny or the development of bone is one of the most interesting and instructive subjects connected with the whole study of general anatomy; but, in an elementary treatise like the present, not even an outline of the entire process can be given. It must suffice, therefore, to state that, in the earliest stage of fœtal life, the bones, in common with all other organs of the body, exist in the form of a homogeneous mucous or jellylike mass, which, under the microscope, consists of nucleated cells floating in a semiopaque consistent fluid or blastema. Out of this mucus temporary cartilages are produced, which have the external form of the future bones, and in these cartilages the earthy or ossific matter is deposited. The change into cartilage is completed about the end of the eighth week; but before this time, at about the sixth or seventh week, the cartilages of the clavicle and lower jaw are entirely formed, and ossification commences in these parts. A few days later, ossific points may be discovered in the shafts of the femur, tibia, and humerus, and in the upper jaw; next, in the cervical vertebræ, ribs, cranial bones, fibula, scapula, etc. At birth, the bodies of the long bones generally, the bodies and laminæ of the vertebræ, and most of the broad bones are far advanced; some of the tarsal bones have just begun to ossify, while the epiphyses of the long bones, the carpal, and most of the tarsal bones are still in a cartilaginous state.

Fig. 42.

Femur, from an individual about sixteen years of age, exhibiting the diaphysis (1) distinct from the epiphyses (2, 3, 4, 5).

The *epiphyses* are developed independently of the bodies, or, as they are technically termed, the *diaphyses* of the bones, from separate centres of ossification, the first of which makes it appearance in the condyles of the femur and head of the tibia, immediately after birth. The period at which the epiphyses become united by bony matter to the diaphyses varies in the different bones, and will be mentioned in connection with the description of the latter. Before this is effected, the long bones continue to grow in length, but when the two parts become fused together in one piece, which does not take place until some time after the age of puberty, and in some bones not until about the twenty-fifth year, no farther development in this direction can occur. Their growth in thickness, however, being effected by means of

the periosteum, as heretofore mentioned, may continue until after middle life, or possibly even until advanced age.

CUTANEOUS TISSUE.

The Skin or common integument invests the external surface of the body, and is continuous, at various points, with the mucous membrane that lines the internal open cavities. Its free surface is in many places studded with hairs, and presents a great number of folds or wrinkles, resulting from the flexion of parts or from the contraction of subjacent muscles. This surface is also marked in some situations by numerous fine ridges and intervening furrows (Fig. 43), produced by rows of papillæ to be presently mentioned. Its internal surface is attached to the subjacent parts by areolar tissue, which, in most situations, is sufficiently loose to allow a considerable degree of mobility.

The skin is composed of the epidermis or cuticle, with its prolongations in the form of nails and hairs, and the true skin or dermis, which, besides its proper tactile papillæ, has imbedded in its texture the ducts of the sebaceous and sudoriferous or sweat glands.

The **Epidermis** has been already described as one of the varieties of epithelium (page 57). It varies in thickness in different individuals and in different situations, being thicker in laboring people who are exposed to the weather, than in those who "wear soft raiment and live in kings' houses," and thicker on the palms of the hands and the soles of the feet than in other parts of the body. In the situations just indicated it sometimes measures not less than $\frac{1}{8}$ or $\frac{1}{10}$ of an inch, while upon the eyelids and in some other localities it is not more than $\frac{1}{600}$ of an inch in thickness. Near the free surface it is dry and of a horny consistence, but its deeper layer is of a more soft and plastic nature, and accurately moulded to the surface of the dermis upon which it rests. It is traversed from below by the ducts of the sweat and sebaceous glands which open upon the free surface.

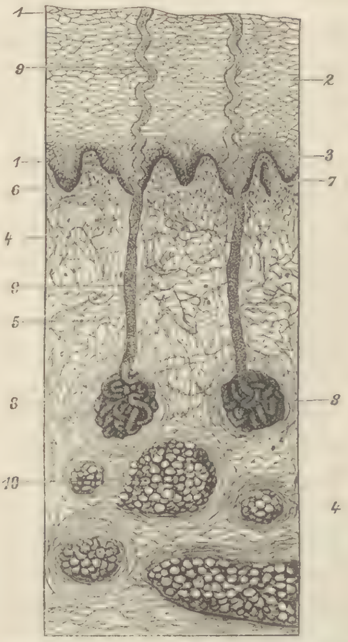
It is composed of nucleated cells agglutinated together by intervening blastema; but the cells differ very materially in their form at different depths of the tissue. Those which lie next to the dermis are of an oval figure, and perpendicular to the surface upon which they rest; while those of the next series are more globular, becoming from this point more and more flattened toward the free surface, where they exist as thin dry scales, which are being constantly detached as scurf or dandruff. The deep layer was for a long time considered a separate structure, denominated the *rete mucosum*, and it is still sometimes referred to under this name to distinguish it from the more superficial horny layer. It is between these two portions that the serum collects in blistering, and in the cells beneath that the pigment is found which distinguishes the colored from the white races, and which, in the latter, produces the brownish hue

of the scrotum, nipple, and circumference of the anus. By the constant development of new cells next to the dermis, the epidermis is being continually renewed, to compensate for the wearing away at its free surface.

Fig. 43.

Surface of the skin of the palm, showing the ridges, furrows, cross-grooves, and orifices of the sweat ducts. The scaly texture of the cuticle is indicated by the irregular lines on the surface. Magnified 20 diameters. (Todd and Bowman.)

Fig. 44.



Section of the skin from palmar aspect of last phalanx of index finger. Magnified 60 diameters. 1, epidermis; 2, its external or horny layer; 3, internal layer or *rete mucosum* of Malpighi; beneath the epidermis the true skin or dermis is represented, also in two layers; 4, its superficial, 5, its deep layer; 6, papillæ of the dermis; 7, a tactile corpuscle; 8, sweat glands; 9, excretory duct of sweat glands; 10, adipose cells.

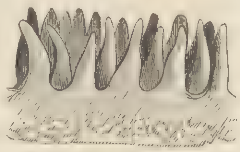
The **Dermis** or true skin (cutis vera, corium) is covered everywhere by the epidermis, which shields its delicately sensitive organization from immediate contact with the surrounding world, and limits the large evaporation which would otherwise take place from the surface. It varies in thickness in different localities, and is connected to the parts beneath by areolar tissue, which is generally loose, and in its texture and in its interstices filled with fat. It consists of a very vascular fibrous membrane, the superficial surface of which presents numerous little prominences known as the tactile papillæ.

The *fibrous layer* forms the deepest part of the dermis, and is composed of very strong, white, undulating fibres, which cross each other in every direction, and are intermixed with numerous yellow elastic and unstriped muscular fibres. Upon the inner surface of the layer the fibrous tissue is rather loosely disposed, leaving tolerably large interspaces generally occupied by adipose tissue, but nearer the cuticle the interlacement is so close and dense, and the fibres so fine, that the interstices can-

not be seen with the naked eye. The thickness of this layer varies in different parts of the body, but, as a general rule, is greatest in the most exposed situations, as in the palms of the hands, soles of the feet, etc.

The *tactile papillæ* are situated upon the external surface of the dermis, and are closely covered by the epidermis, upon the under surface of which they make corresponding pits. They are little conical eminences, composed of a delicate network of vessels, nerves, and areolar tissue, and arranged in curved rows, which are indicated by the fine ridges upon the free surface of the cuticle. Their size and number vary in different parts of the body. Upon the extremities of the fingers they measure from $\frac{1}{120}$ to $\frac{1}{100}$ of an inch in height, and are set so closely as to form a distinct layer, but upon the trunk they are few and small, and upon the face entirely wanting. In the interior of some of the larger ones upon the prepuce, clitoris, and fingers, minute corpuscles have been discovered, which are supposed to belong to the terminations of corresponding sentient nerve filaments.

Fig. 45.



Papillæ of the palm, the cuticle being detached. Magnified 35 diameters. (Todd and Bowman.)

Upon the superficial surface of the dermis, in addition to the papillæ, there is said to exist a delicate transparent layer of structureless material like that found upon the corium of mucous membranes, where it is called basement membrane, from which the epithelial cells are developed; but this has not been satisfactorily demonstrated.

The bloodvessels of the skin are numerous, but limited in their distribution to the dermis, where they form a dense capillary network from which are given off minute branches to the papillæ. Lymphatics also abound in the same structure, and form a most intricate interlacement beneath the papillary substance. The nerves belong principally to the sensory division of the cerebro-spinal system, and vary in their number according to the degree of sensibility of the part. In the extremities of the fingers, toes, and upon the glans penis, they are particularly abundant, and many of them may be traced into the papillæ, where they are said to terminate generally in loops, but sometimes in the little corpuscles or capsules referred to above.

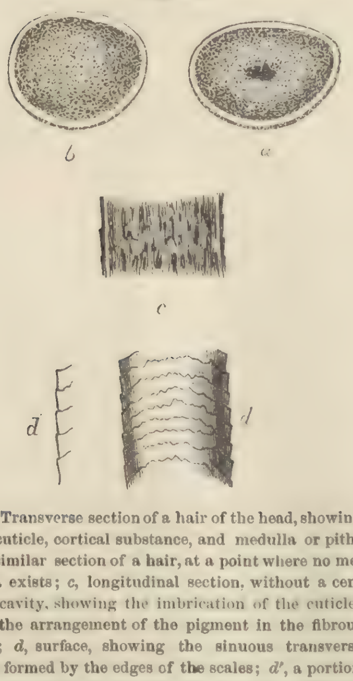
The Nails.—The nails are hard, translucent, horny plates of epidermis situated upon the dorsal aspect of the fingers and toes, and are analogous to the claws and hoofs of the inferior animals. For convenience, each one is divided into three parts: 1. The root or posterior edge, which with the lateral margins are received into an elliptical groove in the dermis, and are partly concealed by the overlapping of the cuticle. 2. The body or uncovered portion, which is attached to the true skin by its inferior surface, and presents upon its external surface near the root a white semi-

lunar division, called the lunula. 3. The free edge, which is the portion that projects beyond the anterior line of the attachment of the body.

The surface of the dermis to which the nail is attached, including the groove in which the root is lodged, is termed the *matrix*. It is studded with numerous papillæ, like those of the skin, which beneath the lunula have no particular arrangement, but, in front of this portion, are placed in longitudinal rows separated by narrow furrows. The nail itself, like the epidermis, is composed of several layers of closely compacted nucleated cells, which next to the matrix are soft, spherical, and surrounded by transparent blastema; but in the middle of the nail, and more particularly on its free surface, they are flattened out, hard, and so compactly and confusedly arranged that it is difficult to discover their outline. The nail being nothing more than ordinary epidermis in a modified form, the two are continuous with each other. The connection occurs upon the upper surface of the organ near its root and lateral edges, and upon the under surface at a little distance from the free margins. The nail grows in length and thickness by the addition of cells at the root and upon its under surface. It possesses neither bloodvessels nor nerves.

The Hair.—The hairs correspond to the fur, wool, and bristles of the inferior animals, and are nothing more than prolongations or threads of

Fig. 46.



a. Transverse section of a hair of the head, showing the cuticle, cortical substance, and medulla or pith; *b*, a similar section of a hair, at a point where no medulla exists; *c*, longitudinal section, without a central cavity, showing the imbrication of the cuticle, and the arrangement of the pigment in the fibrous part; *d*, surface, showing the sinuous transverse lines formed by the edges of the scales; *d′*, a portion of the margin, showing their imbrication. Magnified 150 diameters.

Fig. 47.

The fibres of the stem of a hair. Magnified 670 diameters.

epidermis inserted into the substance of the dermis. Each one is said to have a root or bulb and a free portion or shaft.

The *shaft* differs in length and thickness in different individuals, and in different parts of the same individual. It is generally longer and finer in the white than in the other races, and finer and shorter upon the trunk and extremities of the body than upon the scalp and face. It is usually cylindrical, but sometimes flattened, elastic, flexible, non-vascular, and entirely devoid of sensibility. Under the microscope, it is resolved into three parts: 1st, an external covering or *cuticle* of fine scales slightly overlapping each other and disposed in regular circles around the circumference (Fig. 46, *d′ d*); 2d, the *cortical substance* consisting of translucent fibres (Fig. 47), which have a general longitudinal direction, and are often so very fine and closely adherent that they are with difficulty seen even with the best microscopes; 3d, the *medulla* or pith, which is an opaque granular substance occupying the centre or axis of the hair, but is frequently wanting.

The *root* of the hair (Fig. 48) begins by a bulbous extremity, and is inclosed in a corresponding cavity in the substance of the dermis called the hair follicle, at the bottom of which is the hair papilla.

The *hair follicle* is a flask-shaped recess, occupying the thickness of and sometimes extending a little below the dermis. It is lined by an inversion of the epidermis in a somewhat modified form, and closely embraces the root. It is separated from the dermis by a distinct layer of amorphous material, which forms a true basement membrane.

The *hair papilla* stands up from the bottom of the follicle, and is imbedded in the centre of the hair bulb. It is smaller than the tactile papillæ of the skin, but does not differ materially from them in structure.

The *hair bulb* is continuous at the bottom of the follicle with the epidermic lining of the latter, and consists of nucleated polyhedral cells and a soft intercellular blastema. The growth of the hair takes place by the successive development of these cells, which, as they are pushed outward, gradually transform themselves into the three varieties of material composing the shaft. It is in these cells that the

Fig. 48.

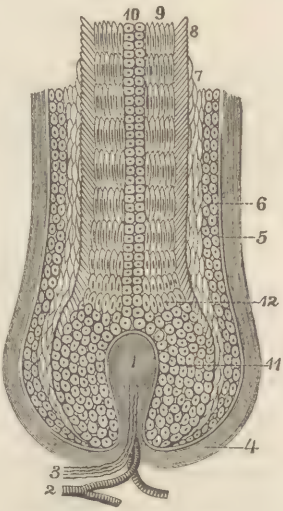


Diagram of structure of the root of a hair within its follicle. 1, hair papilla; 2, capillary vessel; 3, nerve fibres; 4, fibrous wall of the hair follicle; 5, basement membrane; 6, soft epidermic lining of the follicle; 7, its elastic cuticular layer; 8, cuticle of the hair; 9, cortical substance; 10, medullary substance; 11, bulb of the hair composed of soft polyhedral cells; 12, transition of the latter into the cortical substance, medullary substance, and cuticle of the hair.

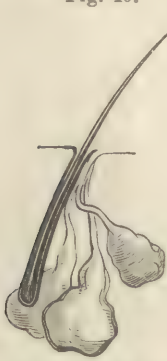
pigment is deposited upon which the color of the hair depends. They are dependent upon the papilla for their production, and when this becomes atrophied, the hair falls out.

Connected with the exterior of the hair follicle near its bottom, and extending thence, along the side toward which the hair inclines, to the superficial part of the dermis, is a fasciculus of unstriped muscular fibre, by the contraction of which the hair is made to "stand on end," and the phenomenon termed "goose-flesh" is produced.

The glands of the skin are of two kinds, the sebaceous, and the sudoriferous or sweat glands.

Sebaceous Glands.—These are found in greater or less abundance in all parts of the skin, except the palms of the hands and soles of the feet. They are almost invariably associated with the hair follicles, and are very numerous upon the scalp, face, scrotum, prepuce, groins, armpits, labia,

Fig. 49.



Three sebaceous follicles taken from the skin of the nose, with an attendant hair. The ducts here open upon the cuticle.

Fig. 50.

A large sebaceous gland from the nose, viewed by transmitted light, and highly magnified. *a*, epithelium of the gland; *b*, the same continuous with the epidermis; *c*, the sebaceous matter; *d*, subdivisions of the gland; *e*, hair follicle; *f*, a hair.

and around the nipple and anus. The simplest form in which they present themselves is that of a single minute recess or saccule imbedded in the superficial part of the true skin, and lined by an inversion of the epidermis. Generally, however, they are larger, more flasklike in shape (Fig. 49), and associated together in groups of two or more around a hair follicle, into the mouth of which they open by one or more ducts. In some situations, as upon the nose, they are still larger, have a branched arrangement at the bottom (Fig. 50), and extend the entire thickness of the skin.

The sebaceous glands secrete a cheesy oily substance, which anoints the

hair and the surface of the skin, rendering them soft and pliable, and repellent of water. Under the microscope, the sebaceous matter is resolved into large cells, some of which are filled with a finely granular substance, and others with oil globules : most of them, however, rupture as they pass through the narrow duct of the gland, and the oil is thus set free. From the glands upon the nose this cheesy substance may often be squeezed as a cylindrical yellow mass, resembling a worm, the head of which is a little black speck of dirt upon the free extremity.

The Meibomian follicles of the eyelids belong to the class of sebaceous glands, and differ from the others only in their shape, which is that of a tortuous canal. They open at the roots of the eyelashes.

The **Sudoriferous** or **Sweat Glands** (Fig. 44) are found in the skin of all parts of the body, but are most numerous in the palms of the hands and soles of the feet. They are larger than the sebaceous glands, and consist each of a single fine tube, continued from a funnel-shaped orifice upon the free surface of the cuticle down through the thickness of the dermis to the under surface of the latter, where it is coiled into a ball and lodged in one of the areolæ of the fibrous tissue. Where the tube passes through the epidermis it is of a spiral form, and its walls are composed only of pavement epithelium, but throughout the rest of its extent it possesses a basement membrane, supported by a thin fibrous coat outside. The cells of its cuticular lining are polyhedral, and contain nuclei surrounded by granular matter. The orifices of the ducts (Fig. 43) may be seen with a common pocket-glass upon the top of the ridges which mark the free surface of the epidermis. The secretion, known commonly as the sweat, is watery fluid, having an acid reaction and a slight salty taste.

The **Ceruminous Glands** of the ear, and the **Odoriferous Glands** of the armpits, resemble in form the sweat glands, but their secretion is different. The former secrete a yellow cheesy matter known as the ear wax. The latter, the odoriferous glands, occupy a space about an inch square in the skin of the axillæ, and furnish a thin fluid, possessing a smell which is said to be peculiar in the different races, and is especially strong and offensive in the negro.

MUCOUS MEMBRANE.

This tissue forms the lining membrane of all the cavities of the body that communicate with the external air, and is, therefore, continuous with the skin at the margins of the great outlets, the mouth, nose, anus, etc. It forms by its distribution two great divisions, called the *gastro-pulmonary* and the *genito-urinary*, the several parts of each of which constitute a continuous layer. The gastro-pulmonary membrane, commencing at the lips, lines successively the mouth, fauces, pharynx, œsophagus, stomach,

and intestines, and furnishes in its course prolongations to the various ducts that open upon its surface; from the throat it is continued upward into the cavities of the nose, the lachrymal passages, and front of the eyes, and into the Eustachian tube and internal ear; from the root of the tongue it extends into the larynx, and thence throughout the windpipe, bronchial tubes, and air vesicles of the lungs. The genito-urinary division in the male, beginning upon the under surface of the prepuce, covers the neck and head of the penis, lines the urethra and bladder, and is thence continued through the ureters to the pelvis, calyces, and even the minute tubuli of the kidney; from the back part of the urethra, it diverges into the prostatic and ejaculatory ducts, and from the latter extends into the seminal vesicles, and through the defferential and efferential tubes to the primary tubules of the testicle. In the female, it lines the internal surfaces of the labia, the clitoris, vagina, neck, and body of the uterus, and the Fallopian tubes; at the internal extremities of the latter it is continuous with the peritoneum; from the vagina it is also continued into the urethra, bladder, etc., as in the male.

In the female, there is a third division connected with the mammary glands, whose ducts are lined by it from their commencement upon the end of the nipple, to their ultimate ramification in the minute lobules of the organ.

The general conformation of the mucous membranes corresponds to that of the surfaces they cover; but in numerous places they are thrown into folds, some of which are permanent and serve to increase the extent of surface, while others are only temporary or accidental, and are always effaced by the distention of the cavities in which they occur.

The external surface of the mucous membranes is attached to the surrounding parts by common areolar tissue, called, from its situation, submucous, which in some places, as in the nose, is short and dense, but in others loose and open. It is in the latter situations that the temporary folds are found. The internal surface is comparatively smooth, and always covered with the peculiar viscid secretion furnished by the follicles imbedded in the substance of the membrane.

Mucous membrane is soft and humid, much less resisting than the skin, and in all animals presents a greater or less degree of redness, according to its vascularity and the amount of blood in its vessels at the time of examination. As a general rule, this redness is greater in the infant than in the adult, and, in all ages, is generally greater in the stomach, pharynx, and rectum, than anywhere else. It is impossible, however, to define the shades of difference which the various parts present in a healthy individual; they can be learned only by repeated examinations and comparisons of these membranes under different circumstances.

STRUCTURE.—Mucous membrane, like skin, consists of an epithelial and a dermic or coroid lamina, together with a set of peculiar little organs

called villi and papillæ, and numerous secreting glands. The *epithelium* has been already described (page 57). The *corium* or *dermis* consists of a dense network of areolar tissue, vessels, and nerves; hence the name, fibro-vascular layer, which is sometimes applied to it. It is continuous below with the submucous areolar tissue, and is overlaid by the *epithelium*, a thin transparent membrane called *basement* or *primary membrane* intervening. This basement membrane cannot, however, be demonstrated in all parts of the mucous system, but only where villi and mucous crypts abound, of which it forms an integral part. Its appearance is that of an amorphous limpid matter, with here and there nuclei and fragments of metamorphosed cells.

Mucous Papillæ and Villi.—These are little eminences found upon the free surfaces of some of the mucous membranes, in connection with which they will be particularly described hereafter. The *papillæ* are well seen upon the tongue, where they have conical and cylindrical shapes, and consist essentially of prolongations of the corium, freely supplied with vessels and nerves and covered with epithelium of a peculiar form. Their office seems to be here connected with the sense of taste. The *villi* are found chiefly upon the mucous membrane of the small intestines, where they are so numerous as to give to the surface the appearance and feel of fine velvet. Like the papillæ, they are also mere prolongations of the corium, inclosing each the radicle of a lacteal vessel, and are intended to increase the extent of the membrane without materially increasing its bulk.

Glands.—The little glands. situated in the substance of the mucous membranes, are of different kinds in different localities, but they may all be referred to two classes, the simple and the compound.

The *simple glands* or *follicles* are cavities or depressions in the corium lined by an inversion of the epithelium. They are either tubular or sacculated, and, with some exceptions, are all provided with excretory orifices. The tubular variety is found in large numbers in the stomach and small intestines, where they are known as the crypts of Lieberkühn, and also in the large intestine and uterus. The sacculated are much larger than the tubular, and may be readily seen with the naked eye. They are distinguished into two kinds, the solitary and the agminated (glands of Peyer); the former are scattered throughout different parts of the alimentary canal, while the latter occur principally in the lower part of the small intestines, where they form patches of various sizes; they have no excretory orifices.

The *compound glands* are much larger than the preceding, and consist of little vesicles or sacs collected into lenticular masses, provided with branching excretory ducts. Their size is various, but does not usually exceed that of a grain of wheat. They are not placed in the substance of the mucous membrane, but beneath it in the submucous

areolar tissue. They exist in great numbers in the lips, palate, œsophagus, trachea, bronchial tubes, and duodenum. In the last locality they are commonly known as Brunner's glands.

The *bloodvessels* of the mucous membranes are very numerous, and form in the submucous areolar tissue, and in the corium, an intricate anastomosis of capillaries, whose arrangement differs according to their situation. From this network minute branches extend into the villi and papillæ, but none are found in the basement membrane or epithelium. Intermixed with these vessels are numerous filaments of *nerves*, belonging mostly to the sympathetic system; and *lymphatics* or *lacteals*, which form plexuses beneath the epithelium and basement membrane, and send branches to the villi.

SEROUS MEMBRANE.

The Serous Tissue is distributed throughout different parts of the body, principally for the purpose of preventing friction between opposed surfaces. It includes, therefore, the serous membranes of the visceral cavities, the synovial membranes of the joints, and the mucous bursæ; but wherever situated, or under whatever name it may be known, it exists as a thin, transparent lamina, forming closed sacs of various sizes. The outer surface of each sac is rough and filamentous for attachment to the surrounding parts, and the internal smooth and moist, and always in contact with itself.

The **Serous Membranes** line the internal cavities of the body and invest the contained viscera. Each consists, therefore, of a *parietal* and a *visceral* portion; the former, as its name signifies, is connected with the internal surface of the walls of the cavity, and the latter covers the included organs. The two form, however, but one sac. The principal structures of this class are the arachnoid of the brain and spinal cord, the two pleuræ, the serous pericardium, the peritoneum, and the vaginal tunics of the testes. They all furnish a thin watery secretion in the form of a halitus or vapor from their internal surfaces, which keeps them moist and smooth.

The serous membranes, although differing somewhat in their thickness, are perfectly transparent, the milky or cloudy appearance they usually present being due to disease or to changes after death. They possess a certain amount of extensibility and elasticity, as is proved by their distention in dropsy, and their retraction after the fluid has been removed. In the healthy state they are devoid of animal sensibility and irritability. The acute pain, of which they seem to be the seat when inflamed, belongs, in all probability, to the tissues with which they are in immediate contact.

STRUCTURE.—The structure of serous membrane is very simple, consisting (1) of a layer of condensed areolar tissue; (2) a layer of basement membrane; and (3) a delicate epithelium. The *areolar*, or, as it is sometimes called, the *fibrous layer*, is composed of fascicles of white filaments of the usual wavy appearance, mixed with a few yellow elastic fibres, and forming a network, whose closeness increases from without inward. The *basement membrane* is a simple, homogeneous, amorphous substance, spread out in an exceedingly thin, transparent layer upon the internal surface of the preceding. Its office, like that of all such structures, is connected in some way as yet unknown with the production of the epithelium beneath which it is placed. The *epithelial layer* (see art. *Epithelial Tissue*) belongs to the tesselated or pavement variety, and in the cavities of the brain and upon the fimbriated extremities of the Fallopian tubes it is ciliated.

The bloodvessels and lymphatics of the serous membranes form an open network in the subserous areolar tissue, and in the fibrous layer, but never enter the basement membrane or epithelium. Nerves may be also detected accompanying the vessels, but they are very few in number.

Synovial Membranes and Bursæ.—The *synovial membranes* are precisely similar to the serous membranes in their general form and structure, and in the office which they fulfil, that of furnishing smooth surfaces between parts that admit of motion; but they differ from them in situation, and in the character of their secretion, which is a consistent, glairy fluid, not unlike the white of an egg.

Synovial membranes are found: (1) in the movable joints, where they are named articular synovial membranes; (2) they also exist as simple bladders, called mucous bursæ, where muscles or tendons pass over bones like a rope over a pulley; where muscles play upon each other, or upon other soft parts; and between the skin and subjacent bony prominences.

The articular synovial membranes line the internal surfaces of the walls of the movable joints, except the cartilaginous surfaces of the opposed bones, although this is disputed by many good anatomists. In some of the joints the membrane forms folds, some of which inclose small masses of fat, while others, with fimbriated margins, float loosely from one part of the cavity to another, and perform no particular office, except that of increasing the extent of surface.

The *bursæ* are flattened bladderlike sacs, each having an external rough surface by which it is attached to the surrounding parts, and an internal smooth surface, moistened by the secreted synovia, and always in contact with itself. The size of the sacs varies when distended from that of a pea to a large walnut, and their number in the whole body is estimated at about 150. In some cases, more or less complete septa are found dividing the sac into several smaller cavities, which may or may

not communicate with each other. Such sacs are said to be multilocular, and do not always contain an epithelial lining.

The bursæ that line the fibrous canals, through which the tendons of the flexor muscles of the hand and foot pass to their insertions, often called *vaginal synovial membranes*, do not differ from the others, except in the complexity of their arrangement, each tendon being inclosed in a synovial tube, reflected in such a way as to line the fibrous canal, and invest the tendon, and yet allow great latitude of motion.

In addition to the membranes here mentioned as composing the serous system, the lining membrane of the heart and bloodvessels, of the ventricles of the brain, and of the labyrinth of the ear, are usually included under this head.

GLANDULAR TISSUE.

The various glands of the body, constituting the Glandular Tissue or System, are separate organs. Each is provided with one or more canals or ducts, which communicate, upon the one hand, with the ultimate structure of the organ itself, and, on the other, with the free surface of the skin or mucous membrane. The organs composing this system are the liver, kidneys, pancreas, mammæ, testicles, ovaries, the salivary and lachrymal glands, and the numerous crypts or follicles connected with the skin and mucous membranes. The office of these glands is to form or eliminate from the blood certain matters, that are either reabsorbed partly or wholly, or cast off entirely from the body. The process and its product are alike called *secretion.** The secretions that are reabsorbed are said to be *recrementitious*, and those that are thrown off *excrementitious;* the salivary and pancreatic secretions belong to the former class, and the urine and sweat to the latter.

The simplest form of a gland is that of a single saclike cavity opening upon a free surface, and lined by a prolongation or inversion of the membrane that covers it. Such are the mucous follicles already described. Compound glands differ from simple ones principally in the multiplication and form of their secreting surfaces.

In the sweat glands and the Meibomian follicles, which form a con-

* The glands, properly so called, are not the only structures that perform a secretory function. The serous and synovial membranes secrete fluids suited to the wants of the parts they invest, and, in the process of nutrition, all the solid tissues of the body select from the circulating fluid materials for their nourishment, and reject others; but in this function, the selected matter enters for a certain time into the structure of the tissues, and the rejected matter comes from their wearing away, whereas in secretion no such incorporation takes place; the eliminated matters are no sooner formed than they are discharged.

necting link between the simple and compound varieties, the secreting surface is disposed in the form of a simple tube, coiled upon itself so as to occupy as little space as possible, and to allow the ready access of bloodvessels. Glands of this kind are called *tubular*. Others, such as the pancreas, salivary, lachrymal, and mammary glands, have a secretory duct that divides and subdivides, and upon its branched extremities and sides are little sacs or saccules, grouped into clusters, these clusters into lobules of various shapes and sizes, and the lobules into larger lobes. This is called the *vesicular* or *racemose* variety.

These two varieties, the tubular and racemose, with numerous sub-varieties, include nearly the whole glandular system. The solitary and the agminated or Peyer's glands and the liver are the only exceptions; the structure of these, however, has not yet been precisely determined.

The secreting cavities of glands are lined by epithelium, consisting usually of a single layer of polyhedral nucleated cells resting upon a delicate structureless membrane (basement membrane), from which they are produced. The excretory ducts contain, in addition to these structures, an external investment of fibrous tissue, in which, in some instances, are found unstriped muscular fibres.

The glands are largely supplied with bloodvessels; for, besides the blood that they require for their nourishment, a large amount is necessary for the production of their special secretions. The nerves of the glands belong for the most part to the sympathetic system, and enter the several organs along with the bloodvessels.

PART II.

THE BONES AND JOINTS.

OSTEOLOGY.

THE SKELETON.

The physical, chemical, and vital properties, as well as the structure and the distribution of the osseous tissue having been already described (see art. *Osseous Tissue*), it now remains to consider the special characters of the separate bones. It is proper to remark that, since they constitute the fixed points in descriptive and surgical anatomy, the bones are probably of more practical importance in the study of these branches than any other structures in the body.

In their natural positions, the bones form a uniform and symmetrical framework called the skeleton, of which the spinal column, connected above with the skull and below with the pelvis, is the centre or axis; to it are appended, above and in front, the ribs, which with the sternum or breast bone constitute the thorax; and four extremities, two superior and two inferior, complete the catalogue.

If we consider as distinct bones only those that are contiguous and not continuous with each other when the body has reached complete development (about the twenty-fifth or thirtieth year), the number of pieces composing the entire skeleton will be 197. Of these:

The spinal column, including the sacrum and coccyx, contains		26
The skull (cranium 8, face 14)		22
The thorax (ribs 24, sternum 1)		25
The superior extremities each, including the shoulder	32	64
The inferior extremities each, including the hip bone	30	60

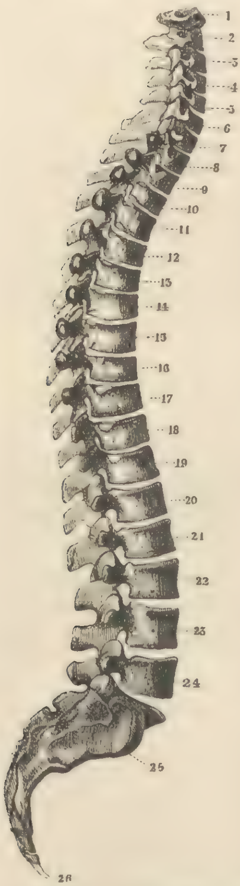
In this enumeration the hyoid bone, the ossicles of the ear (six in number), the teeth (thirty-two), and the sesamoid bones (generally about eight), are not included.

THE SPINAL COLUMN.

The Spinal or Vertebral Column is composed of twenty-six short bones, which form a crooked stem along the middle of the posterior part of the body. It supports the weight of the head, chest, and the superior

extremities, and the greater portion of the abdominal organs. At the same time it constitutes a bony canal for the protection of the spinal cord, and a fixed point for the attachment of numerous muscles. Its whole extent is conveniently separated into four divisions, named after the regions in which they are situated, the *cervical*, *dorsal* or *thoracic*, *abdominal* or *lumbar*, and *pelvic*.

Fig. 51.



Lateral view of spinal column, showing its antero-posterior curvatures. 1 to 7 inclusive, cervical vertebræ; 8 to 19 inclusive, dorsal vertebræ; 20 to 24 inclusive, lumbar vertebræ; 25, sacrum; 26, coccyx.

Of the twenty-six separate pieces, the lowest two of the series are called respectively the coccyx and sacrum, while the remaining twenty-four are known under the common name of vertebræ. The prefix *true* is sometimes added to distinguish the latter from the coccyx and sacrum, which, being in many respects unlike the others, are occasionally called the *false* vertebræ. The cervical portion of the column contains seven bones, the dorsal twelve, and the lumbar five; the pelvic division is composed of only the sacrum and coccyx. Occasionally, however, this distribution is found to vary, six cervical being sometimes combined with six lumbar vertebræ. More rarely the whole number is increased by one, which is usually found in the lumbar region; and in a single remarkable instance which came under the author's notice there were two additional bones, one in the cervical, and the other in the lumbar group, the sacrum being composed of its usual number of pieces.

General Characters of the Vertebræ.—Each vertebra represents a transverse section of the spinal column, and presents certain characters common to all, which it is necessary to understand before proceeding to an examination of the special characters of each class. Thus, each one consists of a body and processes; the former constitutes, as it were, a block of the solid portion of the column, and the latter afford levers or arms for the attachment of muscles, and eminences for articulation with the bones between which it is placed. Being also a segment of the spinal canal, each piece contains a large opening called the vertebral foramen.

The *body*, the largest part of the bone, is situated in front of the vertebral foramen, and presents for consideration four surfaces, of which the

anterior is convex transversely, slightly concave vertically, and marked by numerous small openings for the accommodation of veins and arteries; the *posterior* forms the anterior boundary of the vertebral foramen, is somewhat concave from side to side, and presents the orifices of several large venous canals that emerge in this situation; the *superior* and *inferior*, generally of a circular or oval shape, and slightly excavated, articulate by means of a plate of fibro-cartilage with corresponding surfaces upon the bodies of the contiguous bones.

The *processes* are seven in number: namely, two lateral, one on each side, called the transverse; four vertical, two on each side, named the articular; and one in the median line behind, called the spinous. The roots or bases of the first six are blended together on each side, and are continuous with the seventh, the spinous process, by the two laminæ or arches which complete the lateral boundaries of the vertebral foramen. The whole are connected to the body of the bone upon each side of its posterior surface by a narrow stem of bone called the pedicle.

The *transverse processes* start off immediately behind the pedicles and externally to them. Their general direction is horizontal, but their size, shape, and length vary in the different regions. The *articular processes*, two upon each side, a superior and an inferior, arise in common with the preceding just behind the pedicle, the former passing upward and the latter downward; they present smooth surfaces for articulation with the corresponding processes of the contiguous bones, and rough margins for the attachment of ligaments. The *spinous process*, like the transverse, is intended principally as a lever for the attachment of muscles; it is situated in the median line posteriorly, being connected to the roots of the preceding by means of the laminæ, and it forms a part of that sharp ridge or spine found upon this surface of the spinal column in nearly all vertebrate animals. The *laminæ* are properly the two roots of the spinous process, between which and the bases of the transverse and articular processes they extend in the form of two quadrilateral arches, flattened from within outward. They thus present a superior and an inferior edge for the attachment of ligaments of yellow elastic tissue, which connect these portions of the contiguous bones throughout the entire column. The *pedicles*, as already stated, connect the processes with the body; they are grooved or notched above and below, in such a manner that when two contiguous vertebræ are placed in their natural position, openings are formed called the *intervertebral foramina*, which transmit the spinal nerves. The *vertebral* or *spinal foramen* varies in size and shape in the different divisions of the column, but, in all situations, is large and generally inclined to the triangular form; it is bounded in front by the body of the bone, and laterally and posteriorly by the pedicles, laminæ, and the roots of the transverse, articular, and spinous processes.

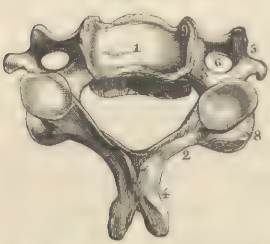
CERVICAL VERTEBRÆ.

The Cervical Vertebræ are smaller than the others, but gradually increase in size from the second to the seventh. For general description, one from the middle of the group is here selected.

The body is longest in its transverse diameter, and a little deeper before than behind ; its superior surface is made concave from side to side by two lateral ridges or crests, within which the corresponding portion of the bone above is received ; the under surface is concave from behind forward, and its lateral margins are rounded. By this arrangement there is an interlocking or mutual reception of the contiguous bones, permitting considerable latitude of movement, but increasing the security of the articulation.

The pedicles are very short, and cannot be readily distinguished from the roots of the transverse processes. Their notches are small and of almost equal depth, the superior being, probably, a very little deeper than the inferior.

Fig. 52.



Upper view of cervical vertebra, from middle of series. 1, body; 2, 3, arch; 4, spinous process; 5, transverse process; 6, its foramen; 7, superior articular process; 8, inferior articular process; 9, elevated lateral border of body.

The articular processes are continuous with each other at their roots, forming little pillarlike masses, whose superior and inferior smooth surfaces are flat and oblique in their direction, the former looking upward and backward, and the latter downward and forward.

The transverse processes are short, perforated vertically at their base by a large foramen for the passage of the vertebral artery, and marked upon the superior surface by a deep longitudinal groove for the lodgment of the corresponding spinal nerve. The anterior border of this groove joins the body of the bone in front of the foramen, and is on a line with the ribs of which it is the cervical representative ; the posterior joins the roots of the articular processes, and corresponds to the transverse processes of the dorsal vertebræ.

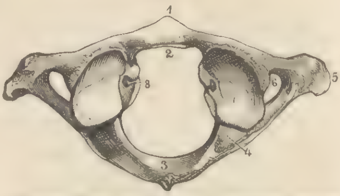
The spinous process is short, triangular prismatic, horizontal, bifurcated at its extremity, and grooved below. The laminæ are long and thin, especially along their upper borders. Their surfaces incline from above downward and backward so that the lower edge overlaps the upper edge of the corresponding part of the next vertebra below. The pedicle is very short and forms the posterior boundary of the opening for the vertebral artery.

The vertebral or spinal foramen is triangular, and, in proportion to the size of the bones, larger than in the other groups ; it measures nearly an inch transversely, and half an inch antero-posteriorly.

The first, second, and seventh cervical vertebræ exhibit important peculiarities which necessitate their separate description.

The **Atlas**, the first of the cervical vertebræ (Fig. 53), has no body, but supports the head above upon its articular processes. In the situation corresponding to the bodies and the pedicles of the vertebræ below, a curved plate of bone, called the *anterior arch*, extends between the roots of the articular processes in front. The anterior convex surface of this arch is marked in the middle line by a small tubercle for the attachment of muscles, and the posterior or internal by a smooth, oval, concave facet for articulation with the odontoid process of the vertebra below. The intervertebral notches, which in the dorsal and lumbar vertebræ occur upon the pedicles, are here placed behind the articular processes; the superior is often converted into a foramen by a little bony bridge, and is occupied by the vertebral artery as well as the first cervical nerve.

Fig. 53.



Upper view of atlas. 1, anterior tubercle; 2, articular facet for odontoid process; 3, arch, with its rudimental spinous process; 4, groove for vertebral artery; 5, transverse process; 6, its foramen; 7, superior articular process; 8, tuberosity for transverse ligament.

The articular processes are thick and strong; the superior, which receive the occipital condyles, are deeply concave, oval from before backward and outward, and look upward and inward; the inferior are circular, nearly plain, and look downward and inward.

The transverse process is long, vertically flattened, triangular, terminated by an obtuse point, and perforated at its root by the arterial foramen, which is large, and directed upward and backward. The length of the process gives great leverage to the muscles which are inserted into it for the rotation of the head.

The laminæ are long, thick, and rounded, and unite in the middle line behind to form the *posterior arch*. At their point of union is a small tubercle, which is the representative of a spinous process.

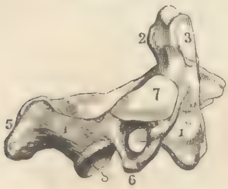
The spinal foramen is larger than that of any of the other vertebræ, and, in the recent state, is unequally divided by a transverse ligament stretched between the roots of the articular processes; the anterior and smaller division is occupied by the odontoid process of the next vertebra; the posterior is the spinal foramen proper.

The **Axis**, the second cervical vertebra (Fig. 54), is principally remarkable for the large *odontoid* process*, formed by a prolongation of the

* Toothlike.

body of the bone vertically upward. This process, measuring about an inch in height, constitutes a cylindrical pivot upon which rotation of the head is performed through the medium of the atlas, and presents upon its anterior and posterior aspects smooth facets corresponding to the anterior arch and transverse ligament of the atlas, with which it is articulated. Its summit is rough for the attachment of ligaments; its middle somewhat constricted, and its base laterally expanded, so as to form two shoulders upon the body of the bone for the superior articular processes. The latter are large, circular facets, nearly horizontal in their direction, but inclined a little downward and outward, so as to transmit the weight of the head from the articular processes of the atlas to the bodies of the vertebræ below. The superior intervertebral notches are superficial, and situated behind the articular processes.

Fig. 54.



Side view of the axis. 1, body; 2, odontoid process; 3, articular facet; 4, arch; 5, spinous process; 6, transverse process, with its foramen; 7, 8, superior and inferior articular processes.

The transverse processes are small, triangular, and bent downward; they are neither grooved above, nor bifurcated at their extremities, and the foramen for the vertebral artery, which is here more properly a canal, is directed upward, outward, and backward. The spinous process is broad and thick, triangular prismatic in shape, and longer than that of any of the other bones of the group except the seventh; it is channeled underneath to accommodate the superior edge of the same process of the bone below, and terminates in two tubercles for the attachment of muscles. The laminæ correspond in size and strength to the spinous process. The spinal foramen is large and heart-shaped.

The Vertebra Prominens or seventh cervical vertebra is the largest of the group, and approximates in character to the dorsal group, with the first one of which it is articulated. It is remarkable for the length of its spinous process, which projects so far beyond the others as to be readily felt beneath the skin, and forms an important landmark in examining this portion of the spine.

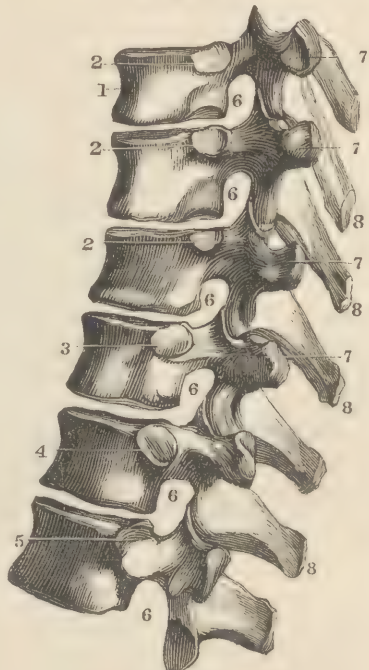
DORSAL VERTEBRÆ.

The Dorsal Vertebræ, twelve in number, are intermediate in situation and size between the cervical and lumbar; they decrease, however, from the first to the fourth, but from the latter increase successively, so that the fourth and fifth are the smallest, and the twelfth the largest. Their bodies are a little longer transversely than antero-posteriorly, thicker behind than before, flat and plain above and below, convex in front, but concave behind; on the back part of each side are two small half pits (Fig. 55, 2), one above and the other below, which form, with the corre-

sponding depressions on the contiguous vertebræ, smooth, oval-shaped excavations for articulation with the heads of the ribs.

The articular processes are vertical, the superior having their articulating surfaces turned directly backward, and the inferior forward. The transverse processes are thick, strong, somewhat tubercular, and bent obliquely backward; upon the anterior part of their extremities is a smooth, shallow excavation for articulation with the tubercle or shoulder of the rib above. The spinous processes are triangular prismatic, long, tuberculated at their extremities, and nearly vertical, so that when the bones are in position the groove on the under edge of the process above receives the upper edge of the one below. The pedicles present a very slight notch upon their superior margins and a very deep one underneath. The spinal foramen is circular and somewhat smaller than in the other divisions.

Fig. 55.



Lateral view of the six inferior dorsal vertebræ. 1, body of the vertebra; 2, 2, 2, rib-depressions formed in contiguous vertebræ; 3, 4, 5, three last dorsals, in which the pit for the head of the rib is formed entirely in its respective vertebra; 6, 6, intervertebral foramina; 7, 7, articulating facets of the transverse processes, for receiving the tubercles of the ribs; 8, 8, spinous processes; 9, articular or oblique process.

The *first dorsal vertebra* possesses many of the characters of the cervical group. Its body is considerably elongated transversely, concave upon its upper surface, and presents an entire facet for the head of the first rib, and a small part of another for the second. The *tenth*, *eleventh*, and *twelfth* approximate in character to the lumbar; the body of each is large, somewhat transversely elongated, and is marked upon each side by an entire facet (Fig. 55, 3, 4, 5) for the corresponding rib. The transverse processes are very short, and those of the eleventh and twelfth have no articulating surfaces. The spinous process is horizontal, strong, and nearly quadrilateral.

LUMBAR VERTEBRÆ.

The Lumbar Vertebræ are the largest in the column. Their bodies are much broader transversely than antero-posteriorly, thicker in front

than behind, flat above and below, and, like the cervical, grooved or constricted anteriorly and at the sides.

The pedicles are very short, thick, and strong, with well-marked notches of which the inferior are the deeper. The articular processes are broad, strong, and vertical in their direction; the facets of the superior are concave and present backward and inward; those of the inferior are convex, turned forward and outward, and are so much nearer the median line than the superior as to be received within those of the bone below. The transverse processes are long, thin, horizontal, and bent but very little backward. The spinous processes are flattened from side to side, quadrangular in shape, directed horizontally backward, and terminated by rough vertical borders. The laminæ are thick and broad, but very short. The spinal foramen is large and triangular.

The *last lumbar vertebra* is somewhat different from the others; its body is remarkably wedge-shaped, being, as it were, cut away below from behind forward and downward; its tranverse processes are generally large, and its inferior articular processes have a flat facet, which looks directly forward.

THE SACRUM.

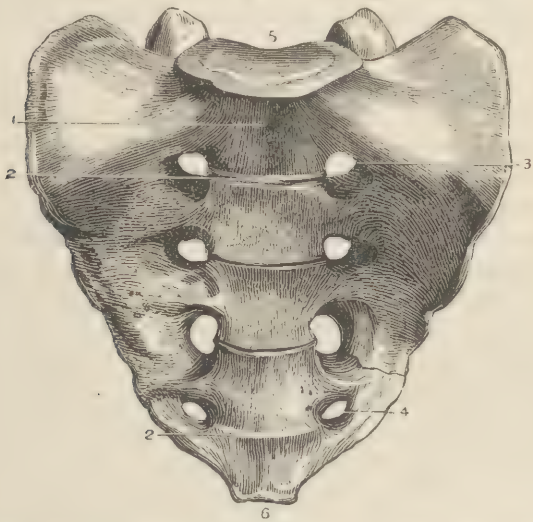
The Sacrum, the largest of the spinal bones, forms the posterior median wall of the pelvic cavity, where it is inclosed by the innominate bones on its sides, the lumbar vertebræ above, and the coccyx below. It is quadrangular pyramidal in shape with its base presenting upward, somewhat flattened from before backward, curved, with its concavity forward, and, when in position, is directed obliquely downward and backward, forming with the lumbar vertebræ an obtuse angle called the *promontory of the sacrum.* Its four surfaces, base, and apex require a separate consideration.

The *anterior* or *pelvic surface* is concave from above downward, and slightly so from side to side. It is marked along the middle by four transverse lines or ridges, which correspond to the points of union between the separate pieces of which the bone was originally formed. At the extremities of these ridges are the four pairs of large circular holes called the *anterior sacral foramina,* which decrease in size from the uppermost; they transmit the anterior sacral nerves, veins, and small arteries. Externally to these are superficial horizontal grooves for the nerves to rest upon, and between the grooves smooth spaces from which the pyriform muscles take their origin. The degree of concavity of this surface of the sacrum is subject to great diversity in both sexes, and is probably not characteristic of either.

The *posterior surface* is convex and somewhat narrower than the anterior. It presents in the median line a prominent ridge, called the *sacral spine,* formed by the junction of four processes analogous to the

spinous processes of the vertebræ; its lower extremity is bifurcated, and constitutes the borders of the inferior opening of the sacral canal. Upon each side of the spine is a broad longitudinal groove, the *sacral groove*, bounded externally by a raised edge corresponding to the transverse pro-

Fig. 56.



Anterior view of sacrum. 1, first bone of sacrum, the four inferior pieces following consecutively; 2, lines of union between pieces; 3, upper, and 4, lower sacral foramina; 5, surface for articulation with last lumbar vertebra; 6, articulating surface for coccyx.

cesses of the vertebræ. In the middle of the groove is another vertical but not very distinct ridge corresponding to the articular processes, and upon the outside of this are the four *posterior sacral foramina*, smaller than the anterior, and intended for the transmission of the posterior sacral nerves together with a few veins and small arteries.

The triangular *lateral surfaces* or borders, broad above and narrow below, slope obliquely from above downward and inward, and from before backward and inward, so that the bone is wedge-shaped in two directions. The upper part of each of these surfaces presents a large *auricular* surface* for articulation with the ilium, and behind this a number of small, rough, angular prominences for the attachment of the strong sacro-iliac ligaments. The border below gives attachment to the sacro-ischiatic ligaments.

The *base* of the bone presents in front an oblique, transversely oval, plain surface for articulation with the body of the fifth lumbar vertebra; on each side a broad, flaring, shoulderlike surface, triangular in shape,

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* Ear-shaped.

convex, smooth, and continuous with the fossa of the ilium when the bones are in position; and behind, the triangular opening of the sacral canal. the borders of which are formed by two laminæ terminating in the sacral ridge. Between the oval surface and the laminæ are the articular processes, which stand vertically upward with their smooth faces looking backward to join the corresponding processes of the last lumbar vertebra. In front of each of these is a groove which forms a part of the last lumbar intervertebral foramen.

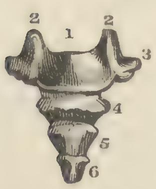
The *apex* is blunt, directed downward and forward, and presents a transversely oval convex surface for articulation with the coccyx. Behind this is the termination of the sacral canal, whose borders end in two small tubercles called the *sacral horns* or cornua, which articulate with corresponding eminences upon the coccyx.

The *sacral canal* is the continuation of the spinal canal, and follows the curve of the bone. It is triangular prismatic and large above, diminishes rapidly as it descends, and communicates with the anterior and posterior foramina. Its posterior wall is wanting below, but in the recent state the deficiency is made up by ligamentous bands stretched from side to side. The canal lodges the sacral nerves which emerge at the two sets of openings.

THE COCCYX.

The Coccyx, the terminal bone of the spinal column, is composed of three or four separate pieces analogous to the tail bones of the lower animals. They diminish successively in size from above downward, the last being a mere nodule; but taken together they form a triangular, pyramidal bone, flattened from before backward, and articulated by its base to the extremity of the sacrum.

Fig. 57.



Posterior view of coccyx. 1, first piece forming base which articulates with sacrum; 2, 2, horns or cornua; 3, notch for fifth sacral nerve; 4, second piece; 5, third piece; 6, fourth piece.

Its *anterior surface* is smooth, concave from above downward, and marked by transverse lines indicative of its division; the *posterior* or subcutaneous surface is rough for the attachment of ligaments, and also marked by transverse lines.

The *sides* or *borders* are thin and sinuous, and give attachment to the coccygeal muscles and the sacrosciatic ligaments. The *base* presents a transversely oval concave surface for articulation with the sacrum, and, behind this, two vertical eminences or cornua, which articulate with corresponding projections upon the lower back part of the sacrum. Upon the outside of these are two *notches*, converted into foramina in the recent state by ligaments, and occupied by the last (fifth) sacral nerve. The *apex* is blunt and tubercu-

lar, sometimes bifurcated, and often bent to one side or the other. In old persons this bone is frequently found anchylosed with the sacrum.

THE SPINAL COLUMN IN GENERAL.

The Spinal Column, as before mentioned, limits the extent of the trunk of the body; but its length does not correspond to the height of the individual, or to the extent of the spinal cord, this organ, in fact, rarely reaching below the first lumbar vertebra. Measured along its curves in the adult after the twenty-fifth year, its length is about twenty-seven or twenty-eight inches; but in a straight line from the atlas to the point of the coccyx it is two inches less. These dimensions do not differ materially in the tallest and shortest persons, the relative height depending principally upon the length of the lower extremities.

The distribution of the length among the different regions is as follows: the cervical portion, five and a half inches; the dorsal, ten inches; the lumbar and sacro-coccygeal, each about six and a quarter inches.

Although the general direction of the column is vertical, it presents several alternate antero-posterior curves, which depend, with the exception of the last, on the different degrees of thickness of the anterior and posterior parts of the bodies of the vertebræ, and the intervertebral fibro-cartilages. The order in which these occur is as follows; in front, a convexity in the cervical region, a concavity in the dorsal, a convexity in the lumbar, and a concavity in the pelvic portion. The relative degree of these curves is always the same, so that when one becomes increased the others will be found to correspond. Their use consists in the greater strength which they give to the column in a vertical direction, according to a well-known law in physics, that of two rods of equal size, one curved alternately and the other straight, the former will support a much greater weight placed upon its sides in a vertical direction.

Besides the antero-posterior curves, a slight lateral one generally exists in the upper part of the dorsal region, presenting its convexity toward the right side. It is not yet conclusively decided whether this is owing to the aorta, whose arch is situated close upon the left side of the column at this point, or, as suggested by Bichat, to the effect of a greater amount of muscular traction toward the right side, the right arm being generally more muscular than the left.

The shape of the vertebral column resembles that of two unequal and irregular pyramids united at their bases; the superior is formed by the true vertebræ, and presents a constriction in the upper dorsal region; the inferior consists of the sacrum and coccyx.

Viewed from before, the column presents the bodies of the vertebræ ranged one above another, each grooved transversely, separated from each other in the recent state by a thick disk of fibro-cartilage, and cov-

ered by the anterior common ligament, which binds them all together. Posteriorly may be observed—1. In the median line, the spine or crest formed by the spinous processes, which vary in size, form, and direction in the different regions, as already described. 2. On the sides of the crest or ridge are the two vertebral grooves, shallow above, broad and deep in the dorsal and lumbar regions, and contracted at the lower part of the sacrum. They are bounded laterally by the transverse processes, closed at the bottom by the laminæ and their connecting elastic ligaments, and occupied by large muscles. The vertebral or spinal canal extends the whole length of the column, and accurately follows its curves, but differs in its shape and size; being triangular in the neck and loins, circular in the dorsal region, and largest in the cervical and lumbar regions.

THE SKULL.

The Skull, by far the most complicated part of the skeleton, is composed of a large number of bones of various sizes and shapes, all accurately and curiously joined together for the support and protection of important and delicately organized structures. It is of an oval shape, flattened upon its sides, larger behind than before, and consists of two parts, the cranium and face; the former incloses the brain and its membranes, and the latter the organs of the senses.

The Cranium, which may be regarded as an expansion of the spinal column, consists of eight separate bones, viz., the occipital, two parietal, the frontal, two temporal, the sphenoid, and the ethmoid.

The Face is composed of fourteen bones, viz., the two superior maxillary, two malar, two palate, two nasal, two lachrymal, two inferior turbinate, vomer, and inferior maxillary.

THE OCCIPITAL BONE.

The Occipital Bone is situated in the lower back part of the cranium. It belongs to the class of broad or flat bones, has a quadrangular outline, is perforated below by a large foramen for the passage of the spinal cord, accessory nerves, and vertebral arteries, and presents for consideration an external and an internal surface, four borders, and four angles.

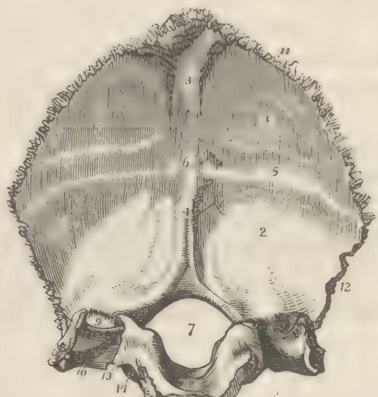
The *external* or *convex surface* (Fig. 58) is marked a little above its centre by a rough prominence called the *external occipital protuberance.* Extending from this point to the posterior border of the great foramen is a slight ridge named the *occipital crest;* and leading off in a lateral direction from the protuberance and from the middle of the crest on each side are two faintly-developed raised lines, denominated the *superior* and *inferior curved lines*, which, with the intervening spaces, give attachment to the large muscles which sustain the head behind. All that part of the surface above the superior curved line is smooth and nearly subcutaneous.

Upon the borders of the great foramen and a little in advance of its transverse axis are the *occipital condyles*, two large, smooth, convex, oblong eminences which articulate with the superior articular processes of the atlas. Their long axes approach each other from behind forward, and at the extremities of each are two depressions called respectively the *anterior* and *posterior condyloid fossæ.* In the former may be seen the *anterior condyloid foramen*, which transmits the hypoglossal nerve, and in the latter the *posterior condyloid foramen*, which, however, is frequently wanting, but gives passage when present to a small vein on its way from the neck to the lateral sinus.

Fig. 58.

External surface of occipital bone. 1, superior curved line; 2, external occipital protuberance; 3, spine; 4, inferior curved line; 5, occipito-spinal foramen; 6, condyle of right side; 7, posterior condyloid fossa, in which posterior condyloid foramen is found; 8, anterior condyloid foramen, concealed by margin of condyle; 9, jugular eminence; 10, notch in front of jugular eminence which forms part of jugular foramen; 11, basilar process; 12, 12, rough projections into which odontoid ligaments are inserted; 13, border for parietal bone; 14, border for temporal bone.

Fig. 59.



Internal surface of occipital bone. 1, left cerebral fossa; 2, left cerebellar fossa; 3, groove for posterior part of longitudinal sinus; 4, vertical ridge for attachment of falciform process of cerebellum; 5, groove for first part of left lateral sinus; 6, internal occipital protuberance; 7, occipito-spinal foramen (foramen magnum); 8, basilar process; 9, groove for terminal portion of lateral sinus, bounded externally by jugular process; 10, jugular fossa, connected with jugular foramen by petrous portion of temporal bone; 11, superior lateral border; 12, inferior lateral border; 13, border for articulation with petrous portion of temporal bone; 14, anterior condyloid foramen.

The *internal* or *concave surface* (Fig. 59) is traversed by a horizontal and a vertical crest which constitutes the *crucial ridge.* The point of crossing is directly opposite the external occipital protuberance, and known from its situation as the *internal occipital protuberance.* The upper half of the vertical ridge gives attachment to the falciform process of the dura mater, and is furrowed by a broad groove for the lateral sinus; the lower half has united to it the falciform process of the cerebellum, and is obscurely marked by the two occipital sinuses. The horizontal division gives attachment to the tentorium, and each lateral half presents a broad

shallow groove for the corresponding portion of the lateral sinus. By means of the crucial ridge, the surface is divided into four excavations called the *occipital fossæ*, of which the superior pair lodge the posterior lobes of the cerebrum, and the inferior the hemispheres of the cerebellum.

The *occipito-spinal foramen* or foramen magnum establishes the communication between the cavity of the cranium and the spinal canal. It is oval from before backward, measures at least an inch in its longest diameter, and appears somewhat larger upon its inner than its outer aspect. Upon its inner border and a little behind its transverse axis may be seen the entrance of the anterior condyloid foramen or canal.

The *superior lateral borders* of the bone are closely dentated for articulation with the parietal bones. The *inferior lateral borders*, irregular but not dentated, join the temporal bones, and are each interrupted about the middle by a projection termed the *jugular eminence*, and immediately in front of this is the *jugular notch* or *fossa*, which with a corresponding but more superficial excavation upon the temporal bone forms the *jugular foramen.*

The *superior angle* is acute, and received between the converging borders of the parietal bones. The two *lateral* are obtuse, and occupy the angle between the parietal and temporal bones behind. The *inferior* or anterior comprises all that part of the bone in front of the great foramen, and is denominated the *basilar process:* it is quite thick, slightly cancave on its upper aspect for the support of the oblong medulla; convex and uneven below, where, covered by periosteum and mucous membrane, it forms the roof of the pharynx, and truncated and rough at its extremity for union with the body of the sphenoid bone, with which, indeed, it becomes fused in middle life.

The occipital bone is united by suture with the two parietal, two temporal, and sphenoid bones, and by movable articulation with the atlas.

THE PARIETAL BONES.

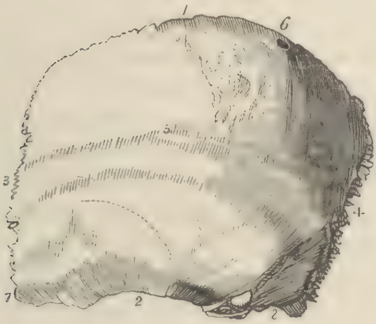
The Parietal Bones occupy the lateral and superior parts of the cranium; they are broad and square, and have each two surfaces, four borders and four angles.

The *external surface* (Fig. 60) is convex, particularly just above its centre, where it forms a kind of prominence, well marked in children, called the *parietal eminence.* Just below this the bone is traversed antero-posteriorly by a curved, slightly raised line forming a part of the *temporal ridge*, which gives attachment to the temporal aponeurosis. Above the ridge the surface is smooth and nearly subcutaneous; beneath it is slightly rough for the origin of the temporal muscle.

The *internal surface* (Fig. 61) is concave, and marked throughout by numerous little prominences and depressions corresponding to the convo-

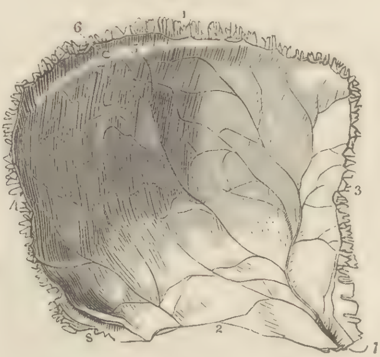
luted surface of the brain, and by arborescent grooves, most of which converge toward the anterior inferior angle, where a complete canal is formed in the substance of the bone for the main trunk of the middle meningeal artery. Near the superior border is a superficial antero-posterior furrow, which is the half of a broad shallow groove for the superior longitudinal sinus. Not unfrequently the groove is formed entirely upon one bone, as the sinus does not always occupy the precise median line. Alongside of the groove are a number of small circular and oval depressions occupied by the Pacchionian bodies, and also a foramen, often wanting, which transmits a vein from the scalp. Upon the inner side of the posterior inferior angle is also a broad but short groove for the lateral sinus which crosses the bone at this point.

Fig. 60.



External surface of left parietal bone. 1, superior or sagittal border; 2, inferior or squamous border; 3, anterior or coronal border; 4, posterior or lambdoidal border; 5, temporal ridge; the figure is situated immediately in front of parietal eminence; 6, parietal foramen, unusually large in the bone from which this figure was drawn; 7, anterior inferior angle; 8, posterior inferior angle.

Fig. 61.



Internal surface of left parietal bone. 1, superior or sagittal border; 2, inferior or squamous border; 3, anterior or coronal border; 4, posterior or lambdoidal border; 5, part of groove for longitudinal sinus; 6, internal termination of parietal foramen; 7, anterior inferior angle of bone, on which is seen groove for trunk of middle meningeal artery; 8, posterior inferior angle, upon which is seen a portion of groove for lateral sinus.

The *superior border*, the longest of the four, is nearly straight, and deeply serrated for union with the opposite bone. The *inferior*, the shortest, is very thin, concave, and cut away, as it were, externally for the overlapping of the squamous portion of the temporal bone with which it is articulated. The *anterior*, thicker than the inferior and dentated or serrated, joins the frontal bone and overlaps it below, but is slightly overlapped by it above. The *posterior*, the thickest and most closely serrated, joins the corresponding border of the occipital bone.

Of the four *angles*, the two *superior* and the *posterior inferior* are nearly square, but the *anterior inferior* is long and narrow, being received between the frontal and sphenoid bones, the latter of which it

overlaps. Upon the inner side of this angle is the canal for the middle meningeal artery.

THE FRONTAL BONE.

The Frontal Bone forms the anterior wall of the cranium, and enters somewhat also into the composition of the face. It is symmetrical, irregularly concavo-convex, and bears some resemblance in form to a bivalve shell. It consists of a vertical or frontal, and a horizontal or orbital portion, each having two surfaces and articulating borders.

Vertical Portion.—The *external surface* (Fig. 62) is nearly regularly convex, and presents in the median line a kind of raphe, or sometimes even a regular suture, indicating the union of the two lateral halves. Upon each side of this middle line, the surface is raised into a slight prominence called the *frontal eminence*, which is particularly well seen in young persons. At the lower extremity of the median line is a well-marked tuberosity named the *nasal boss* or *glabella*, from which two slight elevations, one on each side, called the *superciliary ridges*, pass outward in an arched manner beneath the frontal eminences; they are much more prominent in some persons, especially the aged, than in others. From the middle of the free border of the glabella, which is rough and jagged for articulation with the nasal and superior maxillary bones, a small process, the *nasal spine*, projects downward to join the perpendicular plate of the ethmoid bone behind. Below the superciliary ridge of each side, the margin of the bone is smooth and concave, forming what is called the *orbital arch*, whose extremities are denominated respectively the *internal* and *external angular processes;* the former joins the nasal process of the superior maxillary and the unguiform bone, and the latter the malar bone. About the inner third of each supraorbital arch is the *supraorbital notch*, sometimes a foramen, which gives passage to an artery and a nerve of the same name. Behind, and terminating in the external angular process, is the prominent anterior extremity of the temporal ridge.

Fig. 62.

External surface of frontal bone. 1, frontal eminence of right side; 2, superciliary ridge; 3, supraorbital ridge; 4, external angular process; 5, internal angular process; 6, supraorbital notch for transmission of supraorbital nerve and artery; in figure, almost converted into foramen by small spiculum of bone; 7, nasal tuberosity; swelling around this point denotes situation of frontal sinuses; 8, temporal ridge, commencing from external angular process; depression in which figure 8 is situated is part of temporal fossa; 9, nasal spine.

The *internal surface* (Fig. 63) is deeply concave, and presents in the median line a ridge with a groove upon it for the attachment of the falciform process of the dura mater, and lodgment of the superior longitudinal sinus, the latter having its commencement in a small blind canal called the *foramen cœcum*, which terminates the groove below. The two large fossæ separated by the median ridge correspond to the external eminences, and are occupied by the anterior lobes of the cerebrum.

Fig. 63.

Internal surface of frontal bone; bone raised to show orbito-nasal portion. 1, grooved ridge for lodgment of superior longitudinal sinus and attachment of falx; 2, foramen cœcum; 3, superior or coronal border of bone; figure is situated near part beveled at expense of internal table; 4, inferior border of bone; 5, orbital plate of left side; 6, cellular border of ethmoidal fissure; blind foramen, seen through ethmoidal fissure; 7, anterior and posterior ethmoidal foramina, anterior seen leading into its canal; 8, nasal spine; 9, depression within external angular process for lachrymal gland; 10, depression for pulley of superior oblique muscle of eye; immediately to left is supraorbital notch, and to its right, internal angular process; 11, opening leading into frontal sinuses; leading line crosses internal angular process; 12, external angular process.

Orbital Portion.—This division of the bone consists of two thin triangular plates called the *orbital processes*, which stand horizontally backward from the arches of the orbits to form the roof of the latter.

The superior or cerebral surface of each is convex and mammillated, and supports the anterior lobes of the brain. The inferior or orbital is smooth, concave, and marked near the external angular process by a slight fossa for the lachrymal gland, and near the internal by a very small depression for the attachment of the cartilaginous pulley of the superior oblique muscle of the eye. The inner margins of the two plates are separated from each other by a deep square notch named the *ethmoidal notch*, which receives the cribriform plate of the ethmoid bone; upon its margins are numerous half cells, which are completed by similar excavations in the latter bone, and also two minute notches constituting half of the *anterior* and *posterior orbital foramina;* the former of which gives passage to the nasal branch of the ophthalmic nerve and the anterior ethmoidal artery, and the latter to the posterior ethmoidal artery and vein. The outer margins of the two plates are thin and finely serrated, and articulate with the lesser wings of the sphenoid bone.

The vertical portion of the frontal, like the parietal and occipital bones, consists of two tables and an intervening diploë or spongy tissue. In the nasal eminence and beneath the superciliary ridges, however, the diploic structure is wanting, and in its place are two considerable cavities called

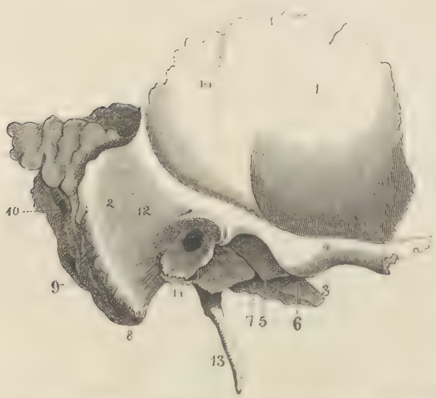
the *frontal sinuses*, which are separated by a thin bony septum and lined by mucous membrane; they communicate through the anterior ethmoidal cells with the cavity of the nose. These cavities do not exist in young persons, but are developed, as age advances, by a separation of the external from the internal table of the bone, and sometimes attain a very large size.

THE TEMPORAL BONES.

The Temporal Bones are situated in the middle of the sides and base of the cranium. They are very irregular, but are considered as consisting of three parts, called respectively the squamous, mastoid, and petrous portions.

Squamous Portion (Figs. 64 and 65).—The Squamous Portion is placed above the other divisions, and forms the lateral wall of the cranium below the parietal bone: it is semicircular, and presents for consideration two surfaces and a border. Its *external surface* (Fig. 64) is slightly convex, smooth, marked in a vertical direction by a small groove for the deep temporal artery, and constitutes a large part of the temporal fossa. From its lower part is given off the *zygomatic process*, which stands out horizontally from the bone by a broad base, but almost immediately turns abruptly forward, becomes narrow and flattened from within outward, and

Fig. 64.



External view of temporal bone of right side. 1, squamous portion; 2, mastoid portion; 3, apex of petrous portion; 4, zygomatic process; 5, glenoid cavity; 6, glenoid tubercle; 7, glenoid fissure; 8, mastoid process; 9, back part of digastric groove; 10, mastoid foramen; 11, auditory process, by extension inwardly, forming vaginal process; 12, external auditory meatus; 13, styloid process; 14, slight impression of deep temporal artery.

terminates in a beveled serrated edge for articulation with the zygomatic process of the malar bone. The two constitute the *zygoma* or *zygomatic arch*, beneath which the temporal muscle passes to its insertion. The origin of the process takes place by three *roots*, of which the *anterior* is directed inward to form the anterior wall of the glenoid fossa; the *middle*, in like manner, to form the posterior boundary of the same fossa; and the *superior*, directed along the upper margin of the auditory meatus, becomes continuous with the temporal ridge. At the point of junction of these several roots is a small tubercle for the attachment of the lateral liga-

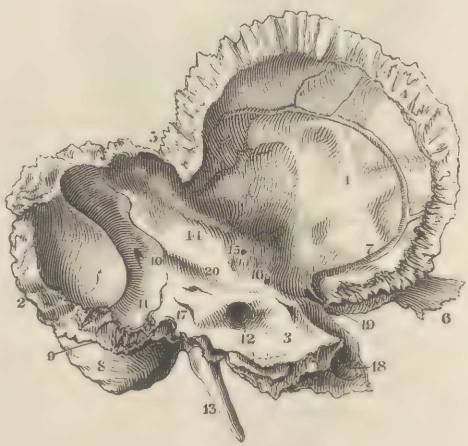
ment of the temporo-maxillary articulation. The *glenoid fossa* just alluded to is a large excavation for articulation with the lower jaw; it is divided by a transverse crack, named the *glenoid* or *Glaserian fissure*, into two unequal parts, of which the anterior and larger, a smooth concavo-convex surface, is the articular surface proper; the posterior being occupied by a prolongation of the parotid gland.

The *internal surface* of the squamous portion (Fig. 65), less extensive than the external, is concave, strongly marked by the convolutions of the brain, and traversed from below by a groove for the middle meningeal artery. The border is semicircular, sharp, and beveled off at the expense of the internal table, so as to overlap the corresponding border of the parietal and sphenoid.

Mastoid Portion (Figs. 64 and 65).—The Mastoid Portion is situated below and behind the squamous. Its *external surface* is convex and rough for the attachment of the sterno-cleido-mastoid muscle, and is prolonged downward and a little forward in the form of a large nipplelike eminence named the *mastoid process.* Upon the inner side of the base of the process is a deep groove, the *digastric groove* (Fig. 66, 12), for the attachment of the digastric muscle. Behind and near the posterior border the bone is sometimes perforated by a small hole, called the *mastoid foramen*, for the transmission of a vein.

The *internal surface* is much smaller than the external, and occupied almost entirely by a deep, broad groove, directed downward and forward, for the lodgment of the lateral sinus. The border is irregularly convex, thick, and serrated for articulation with the occipital bone.

Fig. 65.



Internal view of temporal bone of left side. 1, squamous portion; 2, posterior border of mastoid portion articulating with occipital bone; 3, petrous portion; 4, beveled edge, which overlaps lower edge of parietal bone; 5, thick upper border of mastoid portion, articulating with posterior inferior angle of parietal bone; 6, end of zygomatic process; 7, groove produced by great meningeal artery; 8, mastoid process; 9, digastric groove; 10, mastoid foramen opening into groove 11, for lateral sinus; 12, internal auditory meatus; 13, styloid process; 14, prominence produced by semicircular canal of labyrinth; 15, Fallopian hiatus; 16, foramen for transmission of branch of tympanic nerve; 17, cleft which transmits small bloodvessel to vestibule of labyrinth; 18, termination of carotid canal; 19, Eustachian tube; 20, groove of superior petrosal sinus.

Petrous Portion (Figs. 65 and 66).—The Petrous Portion is situated between and upon the inner side of the squamous and mastoid divisions, projecting inward and forward into the base of the cranium. It is triangular pyramidal in shape, and presents, therefore, a base, an apex, three surfaces, and three borders.

The *base* is directed externally, and is continuous with the squamous and mastoid portions. About its middle is a large circular opening called the *external auditory meatus*, or the entrance to the auditory canal, bounded above by the posterior root of the zygoma, and below and in front by a curved bony lamella called the *auditory process*, which forms also the posterior wall of the glenoid fossa. The margins of the opening are rough, for the attachment of the cartilage of the ear; and the canal, which is somewhat constricted at its middle, leads obliquely inward and forward to the tympanum.

Fig. 66.

Basal view of petrous bone. 1, anterior angle of squamous portion; 2, zygomatic process; 3, tubercle; 4, glenoid cavity; 5, articular ridge; 6, fissure of Glaser; 7, external auditory meatus; 8, plane surface for lodging part of parotid gland; 9, styloid process; 10, mastoid process; 11, stylo-mastoid foramen; 12, digastric groove; 13, tympanic foramen; 14, jugular fossa; 15, jugular ridge; 16, jugular process or spine; 17, aqueduct of cochlea; 18, basal orifice of carotid canal; 19, terminal orifice of carotid canal; 20, bony orifice of Eustachian tube; 21, vaginal process.

The *apex* is irregularly truncated and almost entirely occupied by a large circular foramen, which is the internal extremity of the carotid canal.

The *anterior surface* looks upward as well as forward. It presents, near the superior border, a slight elevation corresponding to the semicircular canals contained within the bone, and, below, a small groove leading obliquely backward and outward to a minute foramen called the *Fallopian hiatus*. The groove lodges the cranial branch of the Vidian nerve, which is transmitted through the hiatus to a canal named the *aqueduct of Fallopius*.

The *posterior surface* looks backward and a little upward, and pre-

sents near its centre a large opening called the *internal auditory meatus*, which is the entrance to the *internal auditory canal.* This canal is very short, and at its bottom, in front, a small cribriform or sievelike plate may be observed, separated by a little crest of bone from the orifice of the aqueduct of Fallopius, which is behind. The canal receives the facial and the auditory nerves, the former of which enters the aqueduct, while the latter passes through the perforated plate to reach the internal ear. Behind and above the meatus is a small fissurelike opening named the *aqueduct of the vestibule.*

The *inferior surface* is narrow, rough, and uneven, and presents the following objects worthy of notice: 1. The *styloid process*, a narrow stem of bone, an inch or an inch and a half in length, standing downward, forward, and inward from near the middle of the surface, to give attachment to three small muscles and the stylo-hyoid ligament. 2. A small opening called the *stylo-mastoid foramen*, which is situated between the styloid and mastoid processes, and gives passage to the facial nerve. 3. A prominent vertical crest or ridge, improperly called the *vaginal process*, situated just in front of the styloid process, and extending from the root of the mastoid process behind the glenoid cavity toward the apex of the bone. 4. Behind the vertical crest a large, deep, smooth excavation called the *jugular fossa.* 5. The inferior orifice of the *carotid canal*, which, followed up, will be found to pass at first vertically and then horizontally inward to terminate upon the apex of the bone.

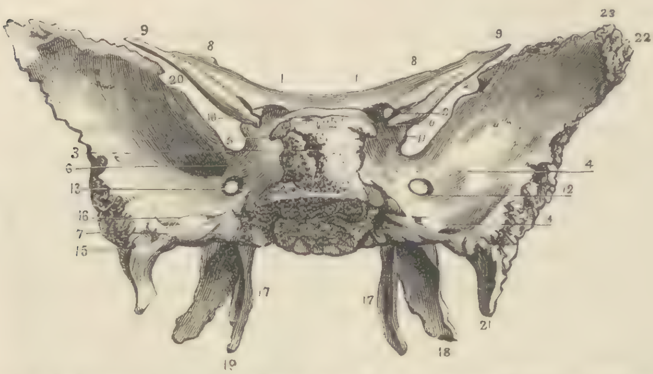
The *superior border* gives attachment to the tentorium, and is traversed by a small longitudinal groove for the superior petrosal sinus, and toward its outer third by a slight prominence corresponding to the semicircular canals. The very short *anterior border* unites with the inferior edge of the squamous portion to form a retreating angle, at the bottom of which may be seen the orifices of two canals, placed one above the other, the inferior and larger constituting the bony part of the *Eustachian tube*, the superior lodging one of the muscles of the tympanum. The *posterior* is rough, and notched near its middle by the jugular fossa, which is sometimes divided into two unequal portions by a spiculum of bone, the *jugular spine*, thus forming with the inferior border of the occipital bone two foramina, of which the anterior and smaller transmits the pneumogastric, glosso-pharyngeal and spinal accessory nerves, and the posterior the jugular vein.

The temporal bone joins the parietal, malar, sphenoid, occipital, and inferior maxillary bones. The squamous portion is composed of compact tissue except along its borders, where a small amount of spongy tissue may be found. The mastoid portion contains a number of cavities lined by mucous membrane and communicating with the middle ear. The petrous portion lodges the organ of hearing.

THE SPHENOID BONE.

The Sphenoid Bone occupies the middle of the base of the cranium, and by its various expansions enters into the composition of some of the most important parts of the cranium and face. It is divisible into a central portion or body and three pairs of processes.

Fig. 67.



Posterior view of sphenoid bone. 1, 8, 9, lesser wings; 2, optic foramen; 3, clivus; 4, 6, concavity of greater wings, for lodging middle lobe of brain; 5, 11, posterior clinoid processes; 7, basilar or cuneiform suture; 10, anterior clinoid process; 12, 13, round foramen; 14, 16, oval foramen; 15, spinous foramen; 17, 17, internal pterygoid process; 18, external pterygoid process; 19, trochlea of internal pterygoid process; 20, 20, sphenoidal fissure; 21, 22, suture for squamous portion of temporal bone: 23, suture for frontal bone.

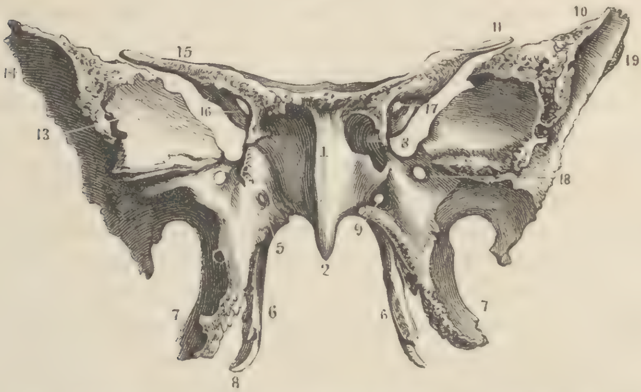
The *Body* of the bone is cuboidal in shape, and has therefore six surfaces.

The *superior surface* (Fig. 67) is marked in the middle by a smooth depression named the *pituitary fossa* or sella turcica, which lodges the pituitary body of the brain. Behind this and overhanging it obliquely, is a square, bony plate, called the *clivus*, the two corners of which are the *posterior clinoid processes.* Upon each side of the fossa is a shallow longitudinal groove for the internal carotid artery, and in front a small eminence, the *olivary process*, supporting a transversely curved furrow leading on each side to the optic foramina: the groove lodges the commissure of the optic nerves from which the nerves themselves pass outward and forward through the foramina.

The *anterior surface* of the body (Fig. 68) forms the posterior wall of the nasal cavities, and presents in the middle line a prominent vertical crest or rostrum, called the *azygos process*, separating the large orifices of the two *sphenoidal cells* or cavities into which the body of the bone of the adult subject is hollowed. These cavities are wanting in childhood, but are gradually developed as adult life advances, and, in old persons, often occupy the whole body of the bone; they are lined by mucous membrane, and open into the nasal cavities.

The *inferior surface* (Fig. 68) is included between the pterygoid processes, and is marked in the median line by a continuation of the ros-

Fig. 68.



Anterior view of sphenoid bone. 1, 2, azygos process or rostrum; 3, sphenoid cells; 5, 9, Vidian or pterygoid foramen; 6, 6, internal pterygoid process; 7, external pterygoid process; 8, hamulus or trochlea of internal pterygoid process; 10, suture for frontal bone; 11, 15, lesser wings; 14, suture for squamous part of temporal bone; 16, 17, optic foramina—these two figures mark sphenoidal fissure of each side; 18, round foramen; 19, external surface of greater wing.

trum, which projects from the middle of the anterior surface. Upon each side of the rostrum is a slight antero-posterior fissure for the reception of the flaring edge of the vomer; and immediately external to this a small furrow which forms a part of the *pterygo-palatine canal.*

The *posterior surface* is quadrangular and rough, for articulation with the basilar process of the occipital bone. The *lateral surfaces* are occupied entirely by the roots of the greater wings and pterygoid processes.

The *Small Wings* (Figs. 67, 68) are two thin triangular plates of bone joined together by their opposed borders along the middle line, and to the body of the bone immediately in front of the olivary eminence. Their superior surfaces are smooth and crossed near the line of union by the olfactory nerves; the inferior form the back part of the roof of the orbits. The anterior borders are sharp and serrated for articulation with the orbital plates of the frontal bone; the posterior are rounded and free, and constitute the upper margin of the sphenoidal fissure. Of the three angles, the posterior terminate in two oval tubercles named the *anterior clinoid processes,* which project backward, and are sometimes found united to the posterior clinoid processes or to the body of the bone along the inner border of the carotid groove by a delicate bony bridge.

The *Great Wings* (Figs. 67, 68), the largest of the three pairs of processes, stand outward from the sides of the body of the bone, and are very irregular in shape; they have each three surfaces and as many corresponding borders.

The *superior* or *cerebral surface* is concave, elongated from behind forward and outward, and constitutes the greater part of the middle fossa of the floor of the cranium. The *anterior* or *orbital surface* looks inward and forward, is quadrilateral and smooth, and forms the larger part of the external wall of the orbit. The *external*, the most extensive of the three, is quadrilateral, elongated from above downward, backward and inward, and is divided by a transverse ridge into two unequal parts, the anterior and larger of which is concave and enters into the formation of the temporal fossa; the posterior, also slightly excavated, constitutes the superior part of the zygomatic fossa, and is rough for the attachment of the external pterygoid muscle.

The *anterior border*, directed obliquely downward and backward, separates the temporal and orbital surfaces, and unites with the orbital process of the malar bone; the *external* divides the temporal and cerebral surfaces, is concave, beveled externally, and somewhat serrated for articulation with the squamous portion of the temporal bone; the *internal* joins the body of the bone in the middle, is free, and forms the outer margin of the sphenoidal fissure in front, and curves outward behind, where it is in contact with the anterior margin of the petrous bone.

The *angle* formed by the three borders in front is truncated; it presents upward and forward, and is triangular in shape, and very uneven, for union with the lower external edge of the frontal bone; that formed behind, by the external and internal borders, occupies the receding angle between the squamous and petrous divisions of the temporal bone, and presents underneath a small pointed prominence called the spinous process.

The *Pterygoid Processes* (Figs. 67, 68) originate from the sides of the body in common with the great wings, and are directed almost vertically downward. Each one consists of two bony laminæ, which are united by their anterior margins to within a short distance of their lower extremities, but diverge behind to form a large deep groove called the *pterygoid fossa*. The external plate is broad and flaring, and forms by its outer surface the vertical portion of the zygomatic fossa; the internal, long and narrow, terminates below in a little hooklike or *hamular process*, for the reflection of the tendon of the circumflex palate muscle, which originates from a little superficial excavation called the *scaphoid fossa*, situated upon the posterior aspect of the root of this plate. The notch formed by the separation of the anterior margins of the two plates below is filled up by the palate bone, which therefore completes the pterygoid fossa in this situation.

Foramina.—Each lateral half of the sphenoid bone presents five foramina and a canal. The largest of these openings is the anterior lacerate foramen (foramen lacerum anterius), or more properly the *sphenoidal fissure;* it is situated between the greater and lesser wings, is triangular in shape, and gives passage to the third, fourth, first branch of the fifth,

and the sixth nerves, and ophthalmic vein. Immediately above and internal to this is the *optic foramen*, which transmits the optic nerve and ophthalmic artery. Just below and near the body of the bone is the *round opening* or foramen rotundum, somewhat smaller than the optic, directed forward and outward, and occupied by the second branch of the fifth pair of nerves. Behind this last, and a little removed outward, is the large *oval opening*, through which the third branch of the fifth pair passes to the lower jaw. The last and least is the *spinous foramen*, situated near the process of the same name, and just without the preceding; it transmits the middle artery of the dura mater. The canal, called the *pterygoid* or *Vidian*, is situated at the base of the pterygoid process, extending horizontally from before backward; its anterior orifice is quite large and distinct, but its posterior is small; it gives passage to the Vidian nerve.

The sphenoid articulates with all the bones of the cranium, and with the palate, vomer, and malar bones of the face.

THE ETHMOID BONE.

The Ethmoid Bone (Fig. 69) is situated in the middle of the anterior part of the base of the skull, in front of the sphenoid, and between the orbital plates of the frontal bone. It is remarkable for its light cellular character, being composed of thin bony laminæ, inclosing numerous large cells which communicate freely with each other and with the cavity of the nose. It consists of a vertical and a horizontal or cribriform plate, and two lateral masses.

The *Vertical Plate* (seen by removing one of the lateral masses) is situated in the middle line of the skull, forms a large part of the bony septum that separates the two nasal cavities, and projects into the cavity of the cranium in the form of a triangular-shaped crest. The nasal portion or *nasal lamella* is broad and quadrilateral, often deviates a little from the middle line to one side or the other, and is marked upon both surfaces by numerous small vascular grooves. It articulates by its anterior margin with the nasal spine of the frontal bone; by its inferior, with the vomer and triangular cartilage of the nose; and by its posterior, with the rostrum of the sphenoid bone.

The cerebral portion of the vertical plate, called the *ethmoidal crest* or crista galli, is situated in the middle of the upper surface of the cribriform plate from which it rises, as it were, from behind forward, and attains an elevation in front of a quarter or third of an inch; its superior border gives attachment to the anterior extremity of the falciform process of the dura mater; its anterior edge separates into two narrow lamellæ, that form with the lower extremity of the ridge, upon the middle of the inner surface of the frontal bone, a small canal, *foramen cæcum*,

for the transmission of a small vein to the longitudinal sinus, and the lodgment of a small process of the dura mater.

The *Horizontal* or *Cribriform Plate* is quadrilateral; it occupies the notch between the orbital portions of the frontal bone, and thus forms a part of the floor of the cranial cavity, and a part of the roof of the nasal fossæ. It is divided into two lateral halves by the crest, and perforated, as its name (cribriform) indicates, by numerous foramina which transmit the branches of the olfactory nerves. Two of these openings, somewhat larger than the others, and situated close to the crest, one on each side, give passage to the nasal twigs of the ophthalmic nerves. Its superior or cerebral surface is slightly excavated on each side of the crest, and supports the bulbs of the olfactory nerves; its inferior surface is covered by the mucous membrane of the nose. Its lateral and anterior borders join the orbital plates of the frontal bone, and its posterior borders the anterior edge of the small wings of the sphenoid bone.

Fig. 69.

Ethmoid bone seen from below. 1, posterior, 2, anterior, extremity of nasal lamella; 3, 3, posterior margins of cribriform plate, and fissure, on each side, separating nasal lamella from lateral spongy portions; 4, 4, anterior portions of same fissures; 5, 5, middle turbinate bones; 6, upper meatus of nose; 7, curved lamellæ of bone that bound upper meatus above; 8, 9, posterior opening of upper meatus; 10, point at which superior meatus communicates with posterior ethmoidal cells; rough projection between 3 and 8 pedicle from which pyramidal process has been detached; seen on opposite side external to figure 3.

The *Lateral Masses* of the bone are quadrangular, and about half an inch thick; they hang vertically from the under surface of the cribriform plate, and form part of the outer walls of the nasal fossæ and inner walls of the orbital cavities. They each present, therefore, two surfaces and four borders. The *external surface*, called sometimes the *orbital plate*, is smooth and quadrangular, parallel with its fellow of the opposite side, and forms by far the greater part of the inner wall of the corresponding orbit. The *internal* or *nasal surface*, situated in the outer wall of the nasal cavity, is rough and uneven, and partially traversed by an antero-posterior groove called the *superior meatus* of the nose, which does not reach as far forward as the anterior border of the bone. Separated by this groove are two thin bony laminæ, rolled, as it were, upon themselves, directed obliquely from before backward and downward, and named, in connection with the nasal cavities, the *superior* and *middle turbinate* bones. (See *Nasal Cavities*.)

The *superior border* is partly connected to the under surface of the cribriform plate, externally to which it projects for articulation with the orbital plate of the frontal bone, and presents a number of half cells and

two small notches; the latter form, when the bones are joined together, the *anterior* and *posterior internal orbital foramina.* The *anterior* and *inferior borders* are also cellular; the former articulates with the unguiform or lachrymal bone, the latter joins the superior maxillary and overhangs the middle groove or meatus of the nose. *Posteriorly,* the lateral masses are prolonged into two peduncular, hollow, triangular pyramidal processes, resting against the anterior surface of the body of the sphenoid bone, and separated by the rostrum. In the young adult, the cavity which each pyramidal process contains opens into the nasal cavity, but in the course of time these processes become blended with the sphenoid, and their cavities go to form part of the cells of this bone.

The lateral masses of the ethmoid are cellular throughout. The cells are of various shapes and sizes; many of them are quite large, separated from each other by thin bony laminæ, and lined in the recent state by a continuation of the nasal mucous membrane. They constitute a part of the olfactory apparatus and are divided into two sets, an anterior and a posterior; the former, larger and more numerous, communicate above with the frontal sinuses, and below by a funnel-shaped passage (infundibulum) with the anterior extremity of the middle meatus of the nose. The posterior set open into the superior meatus.

The ethmoid articulates with two bones of the cranium, namely, the frontal and sphenoid, and with eleven of the face, namely, the vomer in the middle line, and on each side the unguiform, superior maxillary, inferior turbinate, nasal, and palate bones.

BONES OF THE FACE.

The face is situated below and in front of the cranium, and consists of fourteen separate bones, of which two, the vomer and inferior maxillary, are median or symmetrical, and the others are in pairs; they are the superior maxillary, malar, palate, nasal, unguiform, and inferior turbinate bones.

THE SUPERIOR MAXILLARY BONE.

The Superior Maxillary Bone (Figs. 70 and 71), the basis or fundamental piece of the upper jaw, forms the greater part of the front of the face, and lodges the upper teeth. Although very irregular in shape, it is considered as having an external, internal, superior, and inferior surface, and four borders.

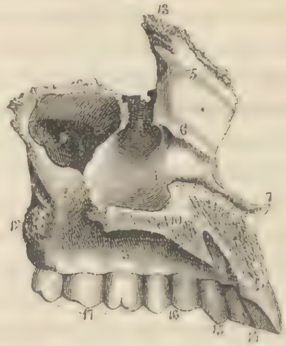
The *external* or *cutaneous surface* is convex, and presents in front two superficial depressions: one very small, situated just above the incisor teeth, and called the *incisive fossa;* the other much larger, and named, from its position between the canine tooth and margin of the orbit, the

canine or *infraorbital fossa.* In the upper part of the latter is the *infraorbital foramen*, the outlet of the small canal of the same name.

Fig. 70.

Superior maxillary bone of left side, outer view. 1, body; 2, tuberosity; 3, alveolar border; 4, orbital plate; 5, nasal process; 6, nasal notch; 7, nasal spine; 8, lachrymal groove; 9, entrance of infraorbital canal; 10, infraorbital foramen; 11, orifices of posterior dental canals; 12, malar process; 13, articulation for internal angular process of frontal bone; 14, incisor teeth; 15, canine tooth; 16, premolar teeth; 17, large molar teeth.

Fig. 71.



Superior maxillary bone of left side, inner view. 1, nasal surface of body; 2, surface for palate bone; 3, alveolar border; 4, orbital plate; 5, nasal process; 6, ridge for articulation of turbinate bone; 7, nasal spine; 8, groove contributing to form lachrymo-nasal duct; 9, maxillary sinus; 10, palate plate, its articulating border for right maxillary bone; 11, incisive foramen continuous with naso-palatine canals; 12, tuberosity; 13, articular extremity for internal angular process of frontal bone; 14, incisor teeth; 15, canine tooth; 16, premolar teeth; 17, large molar teeth.

Externally to the canine fossa is a vertical ridge, and behind this the bone is swollen out into what is called the *maxillary tuberosity*, which forms part of the spheno-maxillary fossa, and is perforated by numerous small foramina for the passage of the superior dental nerves.

The *superior surface*, called the *orbital plate*, is smooth and triangular, inclines from behind a little downward and outward, and forms nearly the entire floor of the orbit. It is traversed from behind forward by a small groove leading to the *infraorbital canal*, which opens in the canine fossa, and transmits the cutaneous division of the second branch of the fifth nerve and a small artery. The internal edge of this surface joins the unguiform bone and orbital plate of the ethmoid. The external is rounded and assists in forming the *spheno-maxillary fissure;* the anterior constitutes the anterior inferior margin of the orbit. Of its three angles, the external forms a thick rough eminence called the *malar process*, the triangular surface of which is serrated for articulation with the malar bone; the posterior is cut off, as it were, for union with the small orbital process of the palate bone; the internal or anterior is continuous with the ascending or nasal process.

The *internal* or *nasal surface* constitutes the external wall of the nasal cavity, and is marked: 1, by two transverse ridges for articulation

with the middle and inferior turbinate bones; 2, in front, by the vertical groove for the nasal duct; and 3, about its centre, by the opening of the maxillary sinus or antrum. In the detached bone this opening is large and triangular, but when the ethmoid, unguiform, palate, and inferior turbinate bones are in place, and covered by the mucous membrane of the nose, it is not larger than an ordinary crowquill. The *palate process* projects from the nasal surface below, and extends nearly its whole length antero-posteriorly. It is a horizontal quadrangular plate of bone forming the floor of the nostril and the roof of the mouth; its superior or nasal surface is smooth and concave from side to side; its inferior, also concave, is rough, for the attachment of the lining membrane of the mouth, and perforated by numerous vascular foramina. Its internal edge is thick and serrated for articulation with its fellow of the opposite bone, with which it forms, in the median line above, a low ridge for union with the vomer, terminating in front in a sharp projection called the *nasal spine.* Upon each side of this median ridge anteriorly is a small foramen, leading to the *anterior palatine canal,* which opens upon the roof of the mouth by a common orifice with its fellow of the opposite bone. The posterior margin is thin, being cut away above for articulation with the palate process of the palate bone.

The *maxillary sinus* or *antrum* is the large pyramidal cavity occupying the body of the bone. Its walls, which are all thin, are the orbital plate above, the nasal surface within, the cutaneous surface in front, and the tuberosity behind: the last two are marked by several fine grooves for the dental branches of the superior maxillary nerve. In the recent state it is lined by mucous membrane, and communicates with the middle meatus of the nose. Its cavity may be readily reached when necessary by extracting one of the molar teeth and plunging a trocar through the socket.

The *anterior* or *nasal border* of the body of the bone curves outwardly below to form the lateral boundary of the entrance of the nasal cavities, and is prolonged upward along the inner border of the orbit to constitute the *ascending* or *nasal process.* This process is flattened from side to side, broad below but narrow above, slightly twisted upon itself, and grooved upon its orbital aspect for the nasal duct. Upon its anterior border rests the nasal bone with which it is articulated; the posterior border joins the lachrymal bone within the orbit. Its upper extremity is closely serrated for articulation with the nasal boss of the frontal bone.

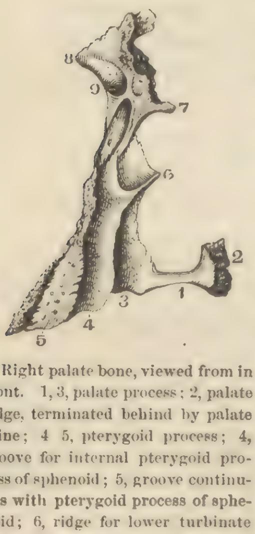
The *posterior border* of the body joins the palate bone, and is marked by a groove which, when the latter is in position, forms the *posterior palatine canal.* The *inferior* or *dental border* is thick and strong, and presents eight *alveoli* or sockets which are separated from each other by thin bony septa, and correspond in shape to the roots of the teeth which they lodge.

The superior maxillary articulates with the frontal, sphenoid, and ethmoid of the cranium, and seven bones of the face, viz.: the nasal, lachrymal, malar, palate, inferior turbinate, vomer, and the superior maxillary of the opposite side.

THE PALATE BONE.

The Palate Bone is situated upon the inner side of the posterior border of the superior maxillary bone, and in front of the pterygoid process of the sphenoid. It consists of a horizontal and a vertical plate, the latter terminating above in two small processes called the sphenoidal and orbital.

Fig. 72.



Right palate bone, viewed from in front. 1, 3, palate process; 2, palate ridge, terminated behind by palate spine; 4 5, pterygoid process; 4, groove for internal pterygoid process of sphenoid; 5, groove continuous with pterygoid process of sphenoid; 6, ridge for lower turbinate bone; 7, pterygoid apophysis; 8, orbital plate; 9, spheno-palatine foramen.

The *Horizontal Plate*, called also the palate process, is quadrilateral, and forms the posterior part of the hard or bony palate. Its *superior* or *nasal surface* is smooth; the *inferior* is rough for the attachment of the mucous membrane of the mouth and the tensor muscle of the palate. Its *anterior border* is thin and rests upon the posterior margin of the palate process of the superior maxillary bone; the *posterior* is free, but concave and sharp, and gives attachment to the soft palate; the *internal* is thick and serrated for articulation with the opposite bone, with which it forms a median ridge above for articulation with the vomer, terminating posteriorly in a small sharp process called the *posterior nasal spine.*

The *Vertical* or *Nasal Plate* is very thin, broad, and quadrangular. Its *internal surface* forms the posterior part of the external wall of the nasal fossa, and is traversed by two horizontal ridges for the attachment of the inferior and middle turbinate bones. The *external surface* is applied to the inner face of the superior maxillary behind, and assists in closing the antrum: it is traversed by a vertical groove that forms with the last-mentioned bone the whole extent of the *posterior palatine canal.*

The *anterior margin* is thin, and forms the posterior boundary of the orifice of the maxillary antrum; the *posterior* is rough, joins the pterygoid process, and terminates below in a thick, triangular pyramidal enlargement, directed downward, backward, and outward, and presenting upon its posterior upper surface three vertical grooves, two for the reception of the anterior edges of the pterygoid plates, and the other, the middle one, for the completion of the pterygoid fossa below. The *inferior* is continuous with the palate plate at a right angle, and connects

the posterior extremity of the alveolar margin of the superior maxillary with the pterygoid process of the sphenoid.

The *superior* border of the vertical plate presents a deep notch which forms the greater part of the *spheno-palatine foramen*, and separates two small processes. The *sphenoidal process*, the posterior and smaller of the two, is rather thin, broad, bent inward toward the median line, where it joins the body of the sphenoid, and forms with it a part of the pterygo-palatine canal. The *orbital process*, situated anterior to the notch and connected to the vertical plate by a thin narrow pedicle, inclines a little outward, and, when in position, appears in the extreme back part of the floor of the orbit. In a well-developed bone this process presents three articulating surfaces, which unite with the corresponding portions of the superior maxillary, ethmoid, and sphenoid bones.

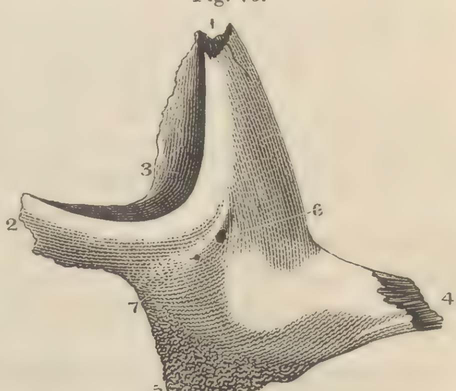
The palate bone articulates with the superior maxillary, sphenoid, ethmoid, vomer, and inferior turbinate bones, and with its fellow of the opposite side.

THE MALAR BONE.

The Malar Bone is situated at the upper and outer part of the face, where it forms the prominence of the cheek. It is irregularly quadrangular in shape, very strong and compact, and has three surfaces, four borders, and four angles.

The *external* or *facial surface* is convex and smooth, and perforated by numerous holes for the transmission of small nerves and vessels. The *posterior* or *temporal surface* is concave, and forms a part of the temporal fossa. The *superior* or *orbital surface* forms part of the outer and lower wall of the orbit; it is semilunar, smooth, and concave, perforated at one or two points to give passage to small nerves, and contributes by its lower border to the formation of the spheno-maxillary fissure.

Fig. 73.



Malar bone of left side. 1, frontal angle or process; 2, orbital process; 3, orbital plate; 4, zygomatic process; 5, maxillary process; 6, foramen for temporo-malar nerve; 7, foramen for arterial twig.

The *superior border* forms the external third of the edge of the orbit, and is consequently concave and blunt; the *posterior* is thin, curved somewhat like the letter S, and gives attachment to the temporal aponeurosis; the *inferior* is con-

tinuous with the lower margin of the zygoma; and the *anterior* is rough for articulation with the superior maxillary.

The *anterior angle* or *orbital process* is long and pointed, and rests upon the superior maxillary; the *posterior* or *zygomatic process* is broad, thin, beveled at the expense of the upper surface, and serrated for articulation with the zygomatic process of the temporal bone; the *superior* or *frontal process* is thick and rough, and supports the external angular process of the frontal bone; the *inferior* or *maxillary process* is obtuse, looks downward and backward, and joins the outer part of the malar process of the superior maxillary.

The malar bone articulates with the frontal, sphenoid, temporal, and superior maxillary bones.

THE NASAL BONES.

The Nasal Bones form what is commonly called the bridge of the nose. They are small and quadrangular, thick and narrow above, broad and expanded below, and present an anterior, smooth, convex, cutaneous surface, and a posterior concave surface, which is finely furrowed for the lodgment of nerves and vessels. The *superior* margin is narrow, but thick and deeply serrated for articulation with the frontal bone; the *external* is grooved where it rests upon the anterior edge of the nasal process of the superior maxillary; the *internal* is quite thick, rough for articulation with its fellow, and, when the two bones are in place, forms a ridge for articulation with the nasal spine and perpendicular plate of the ethmoid; the *inferior* is thin and jagged, and gives attachment to the cartilage of the nose.

Fig. 74.

Left nasal bone, anterior view. 1, frontal border; 2, nasal border; 3, maxillary border; 4, lower border; 5, nasal foramen.

Each nasal bone is articulated with the frontal, superior maxillary, and ethmoid bones, and with its opposite fellow.

THE LACHRYMAL OR UNGUIFORM BONES.

The Lachrymal Bones are the smallest bones of the face, and situated at the internal part of the orbit, below the frontal bone, and between the nasal process of the superior maxillary and the orbital plate of the ethmoid. They are quite thin and quadrangular, and present two surfaces and four borders. The *external* or *orbital surface* is divided by a vertical ridge into two parts, the anterior of which is grooved for the lachrymal sac and commencement of the nasal duct, while the posterior, plain and smooth, completes the inner wall of the orbit. The *internal* or *eth-*

moidal surface is grooved opposite the external ridge, closes some of the cells of the ethmoid and forms a part of the middle meatus of the nose.

Fig. 75.

Right lachrymal bone, external view. 1, orbital surface; 2, lachrymal fossa; 3, small process bounding latter inferiorly; 4, frontal border; 5, ethmoidal border; 6, maxillary border; 7, process articulating with turbinate bone.

The lachrymal bone articulates by its superior border with the frontal bone, posteriorly with the ethmoid, inferiorly with the superior maxillary and inferior turbinate, and anteriorly with the nasal process of the superior maxillary.

THE INFERIOR TURBINATE BONES.

The Inferior Turbinate Bones,* one in each nasal fossa, are thin elongated bony plates curved upon themselves transversely, and attached to the ridge upon the inner surface of the superior maxillary and palate bones. The *inner surface* of each is convex, and looks toward the median line; the *outer* is concave, and presents toward the external wall of the nasal fossa; both are rough and spongy, and, in the recent state, covered by the lining membrane of the nose. The *inferior edge* is free and turned outward; the *superior* is attached along the lower horizontal ridge upon the outer wall of the nasal fossa, and is remarkable for a small vertical prolongation called the *lachrymal process*, which forms the inner wall of the nasal duct, and articulates above with the lachrymal bone.

Fig. 76.

Right inferior turbinate bone, external view. 1, anterior extremity; 2, posterior extremity; 3, lachrymal process; 4, inferior border.

The turbinate bone is remarkable for having its cellular or spongy tissue on the surface, and the compact substance within. It separates the inferior and middle meatuses of the nose, assists in closing the maxillary antrum, and articulates with the superior maxillary, palate, and lachrymal bones.

THE VOMER.

The Vomer is a thin, flat, quadrilateral bone, situated in the median line between the nasal fossæ, and directed obliquely from above downward and forward, frequently, however, inclining a little to one side or the other. Its two surfaces are smooth, but marked by numerous small furrows for the accommodation of nervous and vascular twigs.

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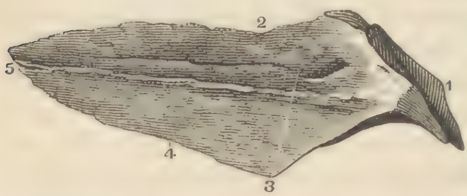
* Called *turbinate* on account of their rolled up appearance, and *inferior* to distinguish them from the middle and superior, which are divisions of the ethmoid.

Of its four margins, the *superior* is short and thick, and divided into two lateral flaring lips, which are separated by an antero-posterior groove; the former is received by the groove upon each side of the under surface of the body of the sphenoid, and the latter embraces the inferior edge of the rostrum. The *inferior* margin is long and thin, and is received into the furrow upon the intermaxillary ridge; the *anterior* joins the nasal plate of the ethmoid and is slightly grooved below for the triangular cartilage that completes the nasal septum in front; the *posterior* is thin, sharp, and unattached.

Fig. 77.



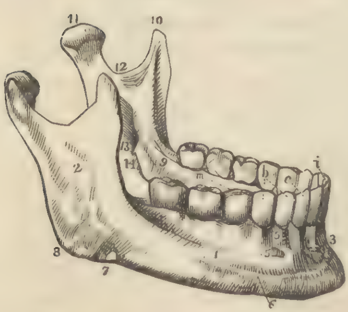
Vomer, lateral view. 1, superior grooved margin, for articulation with azygos process of sphenoid; 2, anterior margin, continuous with nasal lamella; 3, grooves for anterior palatine nerves; 4, inferior margin, to join intermaxillary ridge; 5, anterior angle.

The vomer articulates with the sphenoid, ethmoid, superior maxillary, and palate bones, and with the triangular cartilage of the septum.

THE INFERIOR MAXILLARY BONE.

The Inferior Maxillary or lower jaw bone, the largest and only movable bone of the skull, is situated in the lower part of the face, where it forms the characteristic prominence known as the *chin.* It is shaped somewhat like a horseshoe with its extremities turned up, and is considered, therefore, as divisible into a body and rami or branches.

Fig. 78.



Lower jaw. 1, body; 2, ramus; 3, symphysis; 4. incisive fossa; 5. mental foramen; 6, external oblique line; 7, groove for facial artery, marked by notch in bone little in front of number; 8, angle; 9, extremity of mylo-hyoidean ridge; 10, coronoid process; 11, condyle; 12, sigmoid notch; 13, inferior dental foramen; 14, mylo-hyoidean groove; 15, alveolar processes; *i*, middle and lateral incisor teeth of one side; *c*, canine tooth; *b*, two bicuspids; *m*, three molars.

The *Body* presents an anterior and a posterior or concave surface and two borders. The *anterior surface* is convex transversely, and marked in the middle line by a slight ridge termed the *symphysis*, indicative of the separate development of the two lateral halves of the bone and their subsequent fusion. At the lower termination of the symphysis is the *mental eminence* or prominence of the chin. Upon each side of the symphysis is a small superficial depression named the *incisive fossa*, and just above

and beyond this the *mental foramen*, which transmits from the dental canal the cutaneous branches of the inferior dental nerve and an arterial twig. Below the foramen commences the *external oblique ridge*, which extends backward, becoming more prominent, and is continuous with the anterior border of the ramus.

The *posterior* or *concave surface* exhibits a vertical line in the situation of the symphysis, upon the lower third of which is a small well-defined prominence named the *genial process* for the attachment of muscles. The *internal oblique* or *mylo-hyoid ridge* corresponds to the external ridge and gives attachment to the muscular floor of the mouth. Upon it may be observed a small longitudinal groove for the lodgment of a very small nerve.

The *upper* or *dental border* is horizontal and marked by the sixteen sockets or alveoli of the teeth. The *lower border* or *base* of the bone is horizontal, rounded and flaring, and describes a larger curve than the superior.

By means of the two oblique ridges the body of the bone is divided horizontally into a superior or alveolar, and an inferior or basilar portion. The former constitutes about two-thirds of the depth of the bone in the adult, but becomes entirely absorbed in toothless old people, leaving only the basilar division. The latter, on the contrary, scarcely exists in infants, but only the alveolar portion.

The *Rami* or branches are laterally flattened, much thinner than the body, quadrilateral, and nearly vertical. The *external surface* of each is plain above, but slightly everted, and marked by inequalities below, where it gives attachment to the masseter muscle. The *internal surface* near its middle presents the superior opening of the inferior dental canal, whose inner margin is elevated in the form of a small, vertical, flat spine, for the attachment of the spheno-maxillary ligament. Below the spine is the commencement of the mylo-hyoid groove.

The *anterior border* of the ramus is thicker and slightly grooved below, and gives attachment to the buccinator muscle; the *posterior* is rounded, slightly ridged below, and almost entirely free; the *inferior* is continuous with the base of the bone, and forms with the preceding an angle, which in infants and old toothless individuals is obtuse, but, in the middle aged, is nearly a right angle. The *superior* is sharp, and presents in the middle a semicircular or *sigmoid notch*, terminating in front in a laterally flattened, pointed elevation called the *coronoid process*, into which the temporal muscle is inserted. Behind the notch is a constricted process or *neck*, flattened obliquely from before backward, and surmounted by the articular eminence termed the *condyle*. The condyle is oblong, convex, and smooth for articulation with the glenoid fossa of the temporal bone; its greatest diameter is not exactly transverse, but its axis, if prolonged inward, would pass immediately in front of the occipito-spinal foramen.

The inferior maxillary consists of two laminæ of compact substance inclosing an internal diploic or cellular tissue. The inferior dental canal traverses the latter from above downward and forward; it transmits the dental vessels and nerves and communicates externally by the mental foramen.

The inferior maxillary articulates only with the temporal bone.

GENERAL CHARACTERS OF THE SKULL.

Sutures.—All of the bones of the skull except the lower jaw are united by immovable articulation, the opposed edges presenting, generally, a serrated or toothlike arrangement by which they are dovetailed together. The lines formed by this union are called *sutures*, distinguished from each other by names derived from the bones between which they occur, as, for instance, the spheno-palatine, naso-frontal, etc. Those upon the cranium, however, are still frequently called by their old names; thus, the one between the frontal and parietal bones is called the *coronal;* that between the occipital and parietal the *lambdoidal;* that between the two parietal connecting the coronal and lambdoidal in the middle line of the top of the head, the *sagittal;* and the one between the lower edge of the parietal and upper border of the temporal, the *squamous*.

The use of the sutures was for a long time a matter of dispute among anatomists, but it is now generally admitted that they are necessary to the development of the skull, each individual bone increasing relatively to the others by a deposit of ossific matter upon its edges or circumference. Another important office, although in some measure incidental, is to facilitate the passage of the head of the fœtus through the pelvis of the mother during parturition.

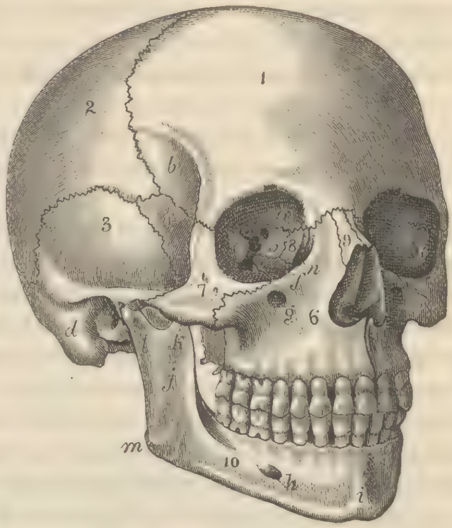
That this is the true use of the sutures is evidenced by the fact that where one or more of the cranial sutures become obliterated in early life, farther growth takes place only in those directions in which this has not occurred. Nearly all anatomical museums contain specimens of this condition; in one found in the collection in the University of Louisiana the sagittal suture is entirely closed, and the cranium having, in consequence, subsequently developed only in the occipital and frontal regions, presents a remarkable and rather ludicrous antero-posterior elongation.

Regions.—The form of the skull is an irregular ovoid, flattened laterally and below, and presents for consideration externally an anterior, a superior, and an inferior surface, and two lateral surfaces or regions.

1. The *Anterior* or *Facial Region* has an oval outline, and may be marked off by a line drawn from the frontal eminence on each side over the cheek bone to the external oblique ridge of the lower jaw bone.

The superior part of this region, constituting what is commonly known as the forehead, is convex and divided into two lateral halves by a median line, or sometimes a suture, upon each side of which above are the *frontal eminences*, and at its lower termination the *nasal boss*, from which the *superciliary ridges* arch outward. Immediately below the boss is the transverse suture, indicating the junction of the frontal bone with the nasal bones and ascending processes of the superior maxillary bones. Below this is the *bridge of the nose*, formed by the two nasal bones, which are united by suture in the middle line, and supported on each side by the nasal process of the superior maxillary.

Fig. 79.



Skull, seen partly in front and on right side. 1, frontal bone; 2, parietal bone; 3, temporal bone, squamous portion; 4, sphenoid bone, temporal surface of great wing; 5, ethmoid bone, orbital surface; 6, superior maxillary bone; 7, malar bone; 8, lachrymal bone; 9, nasal bone; 10, inferior maxillary bone. *a*, orbital plate of frontal bone; *b*, temporal surface; *c*, orbital surface of great wing of sphenoid bone; *d*, mastoid portion of temporal bone; *e*, orbital surface of malar bone; *f*, orbital plate of superior maxillary bone; *g*, infraorbital foramen; *h*, mental foramen; *i*, symphysis; *j*, ramus; *k*, coronoid process; *l*, neck, supporting condyles; *m*, angle; *n*, lachrymo-nasal duct.

At the sides of the nose and below the superciliary ridges are the two large quadrangular openings of the *orbital cavities*, the superior margins of which, called the *supraorbital arches*, are marked by a notch, the *supraorbital notch*, sometimes converted into a foramen, and transmitting the supraorbital nerve and a small artery. Below the orbit on each side are the canine or *infraorbital fossa* and *infraorbital foramen*, the latter for the passage of the infraorbital nerve and an arterial twig. Externally to the orbit is the *cheek bone*, upon which may be seen one or more small foramina for the lodgment of small nerves and bloodvessels.

Beneath the bridge of the nose and between the infraorbital fossæ is the *anterior naris* or entrance to the nasal cavities, shaped like a heart, on playing cards, inverted, and divided in the median line by the anterior border of the vomer and vertical plate of the ethmoid. The *anterior nasal spine* projects from the middle of the lower border of this opening, and below it is the *intermaxillary suture.* Next in order are the two *alveolar borders* and *dental arches*, of which the superior is a segment

of a somewhat larger circle and slightly overlaps the lower. Below the latter is seen the *symphysis* of the inferior maxillary, terminating in the *mental eminence*, and upon each side of the former the *mental foramen*, which transmits the cutaneous branches of the inferior dental nerve.

2. The *Superior Region* or *Vertex* may be defined by a horizontal line drawn upon each side between the frontal eminence and occipital protuberance. It is almost uniformly convex, and marked by the following sutures: 1. The *coronal* or fronto-parietal, formed between the frontal and parietal bones, and crossing the surface anteriorly in a curve whose convexity looks backward; 2. The *sagittal* or biparietal, occupying the median line, and extending from the centre of the preceding to the centre of—3. The *lambdoidal* or occipito-parietal, which is shaped like the letter V inverted, and frequently presents in its course small islets of bone denominated *Wormian bones*. Upon each side of the sagittal suture near its posterior termination is the *parietal foramen*, a small opening not constantly present, which gives passage to a vein from the scalp to the superior longitudinal sinus. Externally to the middle of the suture is the *parietal eminence*, well marked in young children, and below this the superior part of the temporal ridge and fossa.

3. The *Lateral Region* is situated below the preceding and behind the facial region, its inferior boundary being defined by a line drawn between the angle of the jaw and point of the mastoid process. It is considered as subdivided into three smaller regions, named respectively the temporal, zygomatic, and mastoid.

The *Temporal Region* or *Fossa*, the largest of the three subdivisions, is limited, above, by the *temporal ridge*, which forms an arch extending from the external angular process of the frontal bone to the root of the zygoma, and gives attachment throughout to the temporal aponeurosis; below, by a slight ridge that crosses the great wing of the sphenoid not far from the pterygoid process; in front, by the posterior surface of the malar bone; and behind, by the root of the zygoma. The *zygomatic arch* spans the fossa below and gives attachment by its superior border to the lower edge of the temporal aponeurosis, and by its inferior to the masseter muscle. The fossa is filled by the temporal muscle, and upon its surface may be seen arborescent grooves for the deep temporal artery and the squamous and other sutures. A long narrow slit, called the *spheno-maxillary fissure*, communicates between it and the orbital cavity.

The *Zygomatic Fossa* is situated below and internal to the zygomatic arch, and encroaches upon the base of the skull. It is bounded in front by the maxillary tuberosity; above, by the horizontal part of the great wing of the sphenoid; and within by the external plate of the pterygoid process. Upon the posterior part of its superior wall is the *spinous foramen*, through which passes the middle meningeal artery; in front of this, the *oval opening* for the third branch of the fifth nerve. Between

its anterior and internal walls is the *pterygo-maxillary fissure*, which is closed below by the union between the palate and superior maxillary bones, and unites above with the spheno-maxillary fissure at a right angle; near the point of union may be found: 1, the *round foramen*, through which the second branch of the fifth nerve passes; 2, the anterior orifice of the *pterygoid* or *Vidian canal;* 3, the *posterior palatine foramen;* 4, the *spheno-palatine canal.*

The *Mastoid Region* lies behind, anterior, and below the superior root of the zygoma. It presents, behind, the *mastoid process*, the rough external surface of the base of which is the attachment of the sterno-cleido-mastoid muscle. The *mastoid foramen* lies a little farther back, and transmits a small vein from the scalp. In the middle and upper part of this region is the *external auditory meatus*, the margins of which are jagged for connection with the cartilage of the ear. The *glenoid fossa* is in front divided by the *glenoid fissure* into an anterior concavo-convex surface for articulation with the condyle of the lower jaw, and a posterior concave for the lodgment of a part of the parotid gland.

Fig. 80.

Base of skull, right half. 1, palate plate of superior maxillary; **2, palate plate of palate bone**; 3, vomer; 4, internal pterygoid process; **5, external pterygoid process**; 6, pyramidal process of palate bone; 7, under surface **of great wing of sphenoid bone**; 8, its temporal surface; 9, zygomatic arch; 10, zygomatic process **of malar bone; 11, zygomatic** process of temporal bone; 12, squamous portion of temporal; 13, **glenoid tubercle**; 14, glenoid cavity; 15, vaginal process, its outer border constituting auditory process; 16, styloid process; 17, external auditory meatus; 18, mastoid process; 19, digastric groove; 20, basilar process of occipital bone co-ossified with body of sphenoid; 21, condyle; 22, occipital **protuberance**; 23, superior, and 24, inferior semicircular ridges; 25, occipital foramen; 26, incisive **foramen; 27, posterior** palatine foramen; 28, spheno-maxillary foramen; 29, posterior naris; 30, oval foramen; 31, **spinous foramen; 32, lacerate foramen; 33, Eustachian tube; 34, carotid canal; 35, jugular foramen; 36, stylo-mastoid foramen; 37, 38, foramina for veins.**

4. The *Inferior Region* or *Base of the Skull* has an oval outline, and extends, antero-posteriorly, from the base of the lower jaw to the external occipital protuberance, and transversely from one mastoid process to the other. It is divisible into three parts—anterior, middle, and posterior.

The *Anterior Division* is formed by the inferior surfaces of the palate processes of the superior maxillary and palate bones, constituting what is known as the *hard palate*, and by the internal surface of the body and rami of the inferior maxillary. The former, rough for the attachment of the lining membrane of the mouth, is marked in the median line by the suture between the opposite bones,

at the anterior extremity of which is the *incisive foramen* or inferior orifice of the *anterior palatine canals;* its posterior edge is sharp and slightly concave upon each side of the middle pointed process called the *posterior nasal* or *palate spine*, and gives attachment to the soft palate. In front of the extremities of this edge are the orifices of the *posterior palatine canals.*

The *Middle Division* is limited laterally by a line extended from the pterygoid to the mastoid process, and, behind, by one between the two mastoid processes. In the median line anteriorly, the posterior edge of the vomer divides the *posterior nares*, two large quadrilateral openings formed between the body and pterygoid process of the sphenoid and the palate processes of the palate bones, each measuring about twelve lines vertically and six transversely. Externally to these, and between the plates of each pterygoid process, is the *pterygoid fossa*, and at the root of the process the *scaphoid fossa*, in which the circumflex palate muscle has its origin. At the outer side of the root of the process are the oval and spinous openings, and still farther externally the glenoid fossa, already described in connection with the lateral region of the skull.

Behind the vomer is the *basilar process* of the occipital bone, wedged in, as it were, between the internal extremities of the petrous portions of the temporal bones. Upon each of the latter may be remarked the *styloid process*, the *stylo-mastoid foramen*, the inferior orifice of the *carotid canal*, and on its posterior edge the *jugular fossa*, converted into the *jugular foramen* by the occipital bone, and occupied in the recent state by the jugular vein and eighth pair of nerves, the latter placed in front of the former, and separated from it by a projecting crest of bone which divides the foramen obliquely. At the side of the basilar process is an irregular-shaped opening, the *middle lacerate foramen*, with rough jagged margins, formed in a great measure by a deficiency in the apex of the petrous bone, but closed in the recent state by cartilage; the anterior orifice of the carotid canal appears at the same point. Immediately in front of this opening, and forming a part of its margin, is the *spinous process* of the sphenoid bone, and at the base of this the *spinous foramen*. Along the line of union between the petrous portion of the temporal and the great wing of the sphenoid bone, is a groove which lodges the cartilaginous part of the *Eustachian tube*, and leads to the bony canal situated in the receding angle of the former bone.

The *Posterior Division* presents in the median line the *occipito-spinal foramen* (foramen magnum), which transmits the spinal cord and its membranes, the spinal accessory nerves and vertebral arteries. Extending in the middle line from this foramen to the occipital protuberance, is the vertical ridge from which the *superior* and *inferior curved lines* pass off on each side; the lines, and the spaces included between them, give attachment to muscles. Upon the margin of the foramen, a little in front

of its transverse diameter, are the two *occipital condyles* which articulate with the first cervical vertebra. Behind each condyle is a well-marked depression, the *posterior condyloid fossa*, and the opening of the *posterior condyloid canal*, which latter lodges a small vein. In front is another but much smaller, called the *anterior condyloid fossa*, and also a foramen of the same name, which transmits the hypoglossal or lingual nerve.

The division of the skull into the cranium and the face is not less well defined upon its interior than upon its exterior. The cranium contains the cavity for the brain, and the face is occupied principally by the orbital and nasal cavities.

The Cranial Cavity.—This cavity is conformed to the exterior of the brain by which it is occupied, and presents therefore various modifications in form and size in different races and in different individuals. Its general shape is ovoid, the small extremity presenting forward. Being irregularly flattened below it is usually described as having an arched ceiling or vault, and a floor or base.

The *Cranial Vault* is formed by the parietal bones, vertical portion of the frontal, squamous portion of the temporal, and upper half of the occipital. It is tolerably uniformly concave, and over the whole of its surface may be seen the superficial depressions and intervening eminences, corresponding to the convolutions and sulci of the brain; and, upon each side, three sets of arborescent grooves for the lodgment of the anterior, middle, and posterior meningeal arteries. In the median line anteriorly, is the ridge for the attachment of the falciform process of the dura mater, and along the entire length of the line the groove which lodges the longitudinal sinus. The groove is narrow in front, where it passes along the summit of the ridge, but increases in breadth as it passes backward, and, having reached the internal occipital protuberance, divides into the two lateral grooves. In its course may be seen numerous oval pits formed by the Pacchionian bodies, and, posteriorly, the parietal foramen. Farther outward are the large superficial depressions corresponding to the parietal prominences, and, anteriorly, similar ones corresponding to the frontal.

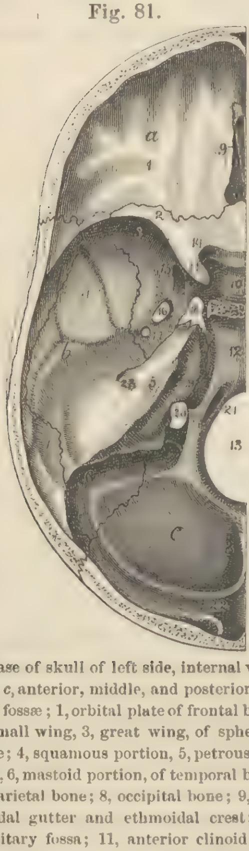
The *Floor of the Cranial Cavity* is very uneven but definitely divisible into three pairs of excavations, named from their relative position the anterior, middle, and posterior fossæ.

The *anterior fossæ* (Fig. 81, *a*) are formed upon the convex surfaces of the orbital plates of the frontal bones and the lesser wings of the sphenoid, and are marked by eminences and depressions, corresponding to the convolutions of the brain, whose anterior lobes they support. Between the two are the *olfactory grooves* for the lodgment of the olfactory nerves, situated upon the cribriform plate of the ethmoid bone, and separated from each other by the *ethmoidal crest* or crista galli; in front of this last is the blind

opening or foramen cœcum, in which the superior longitudinal sinus has its beginning.

The *middle fossæ* (Fig. 81, *b*) are formed by the greater wings of the sphenoid, the anterior surface of the petrous, and the squamous portions of the temporal bones, and separated from the anterior fossæ by the posterior edge of the lesser wings of the sphenoid. They are deeply concave, and, besides the ordinary cerebral depressions and eminences, present grooves for the middle meningeal arteries. Anteriorly, each fossa communicates with the orbital cavity by the *sphenoidal fissure*, behind which may be seen the *round* and *oval openings*. Between the fossæ is the body of the sphenoid bone with its *pituitary fossa;* in front of this are the *optic groove*, the *optic foramina*, and *anterior clinoid processes;* behind, the *clivus* and *posterior clinoid processes*, and, upon each side, the *carotid groove* for the internal carotid artery. In the apex of the petrous bone is the internal orifice of the *carotid canal*, and a little removed externally, a small groove leading to the *Vidian canal* or Fallopian hiatus. The middle fossæ lodge the middle lobes of the cerebrum.

Fig. 81.



Base of skull of left side, internal view. *a*, *b*, *c*, anterior, middle, and posterior cranial fossæ; 1, orbital plate of frontal bone; 2, small wing, 3, great wing, of sphenoid bone; 4, squamous portion, 5, petrous portion, 6, mastoid portion, of temporal bone; 7, parietal bone; 8, occipital bone; 9, ethmoidal gutter and ethmoidal crest; 10, pituitary fossa; 11, anterior clinoid process; 12, declivity; 13, occipital foramen; 14, optic foramen; 15, round opening; 16, oval opening; 17, spinous foramen and groove from it, indicating course of great meningeal artery; 18, lacerate foramen; 19, internal auditory meatus; 20, jugular foramen; 21, condyloid foramen; 22, commencement of groove for lateral sinus; course of groove is observed along horizontal limb of occipital crest, posterior inferior angle of parietal bone, mastoid portion of temporal bone, and transverse process of occipital bone, terminating at jugular foramen; 23, Fallopian hiatus.

The *posterior fossæ* (Fig. 81, *c*), larger and deeper than the others, are formed by the occipital and temporal bones, and contain the hemispheres of the cerebellum. The anterior wall of each is formed by the posterior surface of the petrous bone, presenting the *internal auditory foramen*, and, a little above this, the opening of the *aqueduct of the vestibule.* Farther back may be observed the deep groove of the *lateral sinus*, which, commencing opposite the internal occipital protuberance, runs along the horizontal branch of the crucial ridge, then curves downward over the posterior inferior angle of the parietal and the mastoid portion of the temporal bone, and terminates at the jugular foramen. Between the two are the *basilar process* of the occip-

ital bone, and the *occipito-spinal foramen*, the former somewhat excavated for the Varolian bridge and oblong medulla. Externally, and a little in advance of the occipito-spinal opening, are the two *jugular foramina*, partially divided by the jugular eminence.

Capacity of the Cranium.—The average capacity of the cranial cavity of the Caucasian race, deduced from an examination of a great number of skulls by Dr. Morton, is about ninety cubic inches, with a maximum of one hundred and thirteen cubic inches, the latter the head of a German. The head of the late Mr. Webster, however, exceeded this by nine cubic inches, measuring one hundred and twenty-two cubic inches. But even this last is surpassed by a skull in the museum of the University of Louisville, which the author, with the assistance of Prof. B. Silliman, Jr., found to measure 125·77 cubic inches.* This last is the skull of a German baker, who, according to Prof. Cobb, of the Medical College of Ohio, by whom the specimen was obtained, gave no evidence whatever of more than ordinary intelligence, except that he made a tolerably good loaf of bread.

Diameters of the Cranium.—Dr. Morton gives the average external diameters of the European and Anglo-American skulls as follows:

Longitudinal or *occipito-frontal diameter*, measured between the most prominent part of the frontal bone (generally between the superciliary ridges) and the occipital protuberance	6½ inches.
Lateral or *biparietal diameter*, measured between the parietal protuberances	5½ "
Vertical diameter, measured between the occipital condyles below and the top of the vertex . . .	5 "

The Orbital Cavities.—The Orbits, situated below the anterior fossæ of the cranial cavity, and externally to the cavities of the nose, are formed by parts of seven different bones, namely, the frontal, sphenoid, superior maxillary, palate, lachrymal, ethmoid, and malar. They are quadran-

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* The external measurements of this remarkable skull are as follows:

Occipito-frontal diameter, measured from the forehead about an inch above the nasal boss to the most prominent point of the occiput the same distance above the external occipital protuberance............	8¼ inches.
Biparietal diameter..	6¼ "
Vertical diameter, measured from the anterior part of the sagittal suture to the anterior edge of the occipito-spinal foramen................	6⅕ "
Circumference..	23¾ "
Over the vertex between the centres of the auditory meatuses............	14¾ "

gular pyramidal in shape, and present for consideration four walls, four angles, a base, and an apex.

The *superior wall* or *roof* of the orbit is formed by the orbital plate of the frontal bone and the smaller wing of the sphenoid; it is concave and marked posteriorly by a transverse suture, and anteriorly by two superficial depressions for the lodgment of the lachrymal gland, and the cartilaginous pulley of the superior oblique muscle of the eye. The former of these depressions, called the *lachrymal fossa*, is large but shallow, and is situated just within the external angular process of the frontal bone; the latter is small, not always distinct, and placed near the internal angular process.

The *inferior wall* or *floor* is formed by the orbital plates of the palate, malar, and superior maxillary bones, of which the last mentioned is the most extensive. It is nearly plain, inclines a little outward as well as downward and forward, and is marked behind by the *infraorbital* groove leading forward to the infraorbital canal.

The *external wall*, also nearly plain, is formed by the greater wing of the sphenoid and malar bones. The great outward inclination of this surface deserves to be noticed as giving to the axis of the orbits their divergent direction.

The *internal wall* is shorter than any of the others, and nearly parallel with its fellow of the opposite side. It is formed by the ethmoid and lachrymal bones and the ascending process of the superior maxillary, and presents at its anterior extremity the *lachrymal groove*, leading downward to the *nasal duct*. The groove lodges the lachrymal sac, which communicates through the nasal duct with the inferior meatus of the nose.

The *angles* formed by the four walls are named, from their position, superior internal, inferior internal, etc. The *superior internal* is marked by an antero-posterior suture formed between the orbital plate of the frontal bone above, with the lachrymal and ethmoid below, and by two small foramina, called the *anterior* and *posterior internal orbital foramina*, the former for the passage of the nasal branch of the ophthalmic nerve, the latter for the ethmoidal artery. The *inferior internal angle* presents only the suture formed by the junction of the lachrymal and ethmoid with the superior maxillary and palate bones. The *superior external angle* is closed only in the anterior half of its extent, where sutures formed by the frontal, sphenoid, and malar bones may be seen. The *inferior external angle* is also open in the greater part of its extent. The cavity of the orbit here communicates with the zygomatic fossa by a long narrow slit, called, from its situation, the *spheno-maxillary fissure*, but is closed in front by the union between the malar and superior maxillary bones.

The *base* of the orbit is open and quadrangular, and a little broader transversely than vertically; it is directed forward and outward, being

cut, as it were, obliquely outward and backward. Its area is less than that of the cavity immediately within, all four of its margins being turned inward. Upon the superior margin, will be observed the supraorbital foramen or notch for the passage of the supraorbital or frontal branch of the ophthalmic nerve.

The *apex* corresponds to the optic foramen, below which may be seen the sphenoidal fissure. The former transmits the optic nerve and ophthalmic artery, and the latter the third, fourth, first branch of the fifth and sixth nerves, and the ophthalmic vein.

The *axes* of the two orbits, as already intimated, are not parallel, and if continued backward, would cross each other upon the body of the sphenoid bone.

The **Nasal Cavities or Fossæ** are two large fissurelike cavities which are situated above the roof of the mouth and between the orbits. The frontal sinuses, ethmoidal cells, maxillary sinuses, and sphenoidal cells are also continuations of the same. They are separated from each other

Fig. 82.

Longitudinal section of nasal fossa immediately to right of middle line, bony septum being removed to show external wall of left fossa. 1, frontal bone; 2, nasal bone; 3, ethmoidal crest; 4, cribriform plate of ethmoid; 5, sphenoid cells; 6, basilar portion of sphenoid: bones 2, 4, and 5, form superior boundary of nasal fossa; 7, 7, articulating surface of palatine process of superior maxillary bone, groove between 7, 7, being lateral half of incisive canal, dark aperture in groove inferior termination of left naso-palatine canal; 8, nasal spine; 9, palatine process of palate bone. *a*, superior turbinate bone, with grooves and apertures for filaments of olfactory nerve; *b*, superior meatus; *c*, probe passed into posterior ethmoidal cells; *d*, opening of sphenoidal cells into superior meatus; *e*, spheno-palatine foramen; *f*, middle turbinate bone; *g*, *g*, middle meatus; *h*, probe passed into infundibular canal, leading from frontal sinuses and anterior ethmoid cells: triangular aperture immediately above is opening of maxillary sinus; *i*, inferior turbinate bone; *k*, *k*, inferior meatus; *l*, *l*, probe passed up nasal duct: anterior letters *g*, *k*, on superior maxillary, posterior on palate bone; *m*, internal pterygoid plate; *n*, its hamular process; *o*, external pterygoid plate; *p*, opening of Eustachian tube; *q*, posterior palatine foramina; *r*, roof of left orbit; *s*, optic foramen; *t*, groove for internal carotid artery converted into foramen by osseous spiculum uniting anterior clinoid process to side of, *v*, pituitary fossa; *z*, clivus and posterior clinoid process.

by a median septum which forms their internal wall; besides which, each is considered as having a superior, an inferior, an external, and an internal wall, and two openings, called the anterior and posterior nares.*

The *superior wall* or *roof* is arched, and extends from the anterior to

* For the purpose of studying the fossæ it is necessary to have a skull sawn from before backward, a little to one side of the median line, so as to leave the septum entire upon one side.

the posterior opening; it is formed by the nasal bone in front, the cribriform plate of the ethmoid in the middle, and the body of the sphenoid behind.

The *inferior wall* or *floor* is formed by the palate processes of the superior maxillary and palate bones, and is nearly horizontal; it is much broader than the superior, slightly concave from side to side, and rough for the attachment of the lining membrane; near its anterior extremity may be seen the superior opening of the anterior palatine canal.

The *internal wall* or *nasal septum* is formed by the vomer and the nasal plate of the ethmoid; it is thin, nearly vertical in its direction, but inclines, very frequently, a little to one side, generally the left, and extends from the roof to the floor. It is, however, deficient below and in front, an angular notch here existing which is filled out in the recent state by a triangular plate of fibro-cartilage.

The *external wall* is formed by parts of the ethmoid, superior maxillary, lachrymal, inferior turbinate, and palate bones, and presents for consideration, commencing above: 1, a smooth plane surface on the ethmoid terminating behind in a small curved lamella, called the *superior turbinate* or *spongy bone;* 2, a narrow groove, the *superior meatus*, situated behind the plane surface and below the superior turbinate bone, communicating with the posterior ethmoidal cells, and at its posterior termination with the spheno-palatine foramen; 3, the *middle turbinate bone*, also a portion of the ethmoid, but longer and more curved; 4, the *middle meatus*, a well-marked groove placed beneath the middle turbinate bone, and communicating in front with the anterior ethmoidal cells, and, near the middle, with the maxillary antrum; 5, the *inferior turbinate bone;* 6, the *inferior meatus* or groove, the largest of the three, situated between the preceding bone and the floor of the nose, and communicating with the nasal duct, whose orifice is placed close beneath the margin of the turbinate bone anteriorly.

In the recent state, the nasal cavities are lined by the Schneiderian or pituitary membrane, which, however, does not materially alter the general configuration of the parts, except to narrow the foramina that open into the meatuses.

The Frontal, Sphenoidal, and Maxillary Sinuses, and Ethmoidal Cells.—The *Frontal Sinuses* are cavities contained in the lower part of the vertical or frontal portion of the frontal bone behind the superciliary ridges. They are formed by a bulging forward of the external table of the bone, and vary in size and number at different ages and in different individuals. As a general rule, they consist in the adult of two or three irregular compartments on each side of the median line, capable of containing altogether about a drachm of fluid. The cells of each side open into each other and into the anterior ethmoidal cells below, but not into

those of the opposite side, a median bony septum separating them. In the recent state, they are lined by a prolongation of the nasal mucous membrane, whose surface they thus serve to extend. They serve to increase the strength of that part of the cranial wall in which they are situated without adding to its weight; but this purpose is by no means so evident in man as in some of the inferior animals, the ox, horse, etc., for example, in whom they constitute the great bulk of the skull.

The frontal sinuses are almost entirely wanting in infancy, but are gradually developed after eight or ten years of age, and attain in advanced life a very large size.

The *Sphenoidal Sinuses* occupy the body of the sphenoid bone and communicate with the posterior nares. Like the preceding they are wanting in young subjects, but are gradually developed as age advances, so that, after middle life, they occupy the whole of the body of the bone, and sometimes extend even into the lesser wings of the sphenoid and into the orbital processes of the palate bone. Their number varies; sometimes there are two or three on one side and only one large one on the other, and, at other times, there are a number on both sides. They are almost always separated by a bony septum, which, however, is not often exactly in the median line.

In early life, the anterior wall of the body of the sphenoid bone is covered in, on each side of the rostrum, by the pyramidal processes of the ethmoid, and, as the cells in each become developed, those of the former bone communicate with the cells of the latter, and through them with the nose; but after the age of twenty-five or thirty, the two become blended with each other, and what was once the pyramidal process is then a part of the anterior wall of the body of the sphenoid.

Like the frontal, the sphenoidal sinuses are lined by an extension of the Schneiderian membrane, and open upon each side of the rostrum upon a level with the superior meatus of the nose.

The *Maxillary Sinus* or *Antrum* has been already noticed in connection with the superior maxillary bone, in the body of which it is situated. It is earlier in its development than either of the preceding, being present at birth, and does not seem to increase much in size after maturity. It is lined by a continuation of the mucous membrane of the nasal fossæ, with which it communicates beneath the curved border of the middle turbinate bone, by an orifice which is quite large in the skeleton, but reduced to the size of a crowquill by the investment of mucous membrane.

The *Ethmoidal Cells* are situated in the lateral masses of the ethmoid bone, in which connection they have already been mentioned. They do not all communicate with each other, but are divided into an anterior and a posterior set; the former, large and numerous, open into the frontal sinus and middle nasal meatus in front by a large funnel-shaped passage called the *infundibulum;* the posterior are small and communi-

cate with the superior meatus. They are all lined by a continuation of the nasal mucous membrane.

THE THORAX.

The Thorax is a bony cage, formed by the soft parts into a close cavity to contain the central organs of circulation and respiration. In the skeleton, it is composed of the dorsal vertebræ, the sternum and the ribs, with their terminal cartilages. The vertebræ have been already described.

THE STERNUM.

The Sternum or Breast Bone (Fig. 83) constitutes the middle anterior part of the thoracic wall, forming a shield for the protection of the organs within, and a basis of support for the ribs and clavicles, and through the latter for the superior extremities. It belongs to the class of flat bones, and measures from six to eight inches in length, and from one and a half to two and a half in breadth; it is directed obliquely from above downward and forward. Considering as one the several pieces of which the bone is composed in the young subject, it is somewhat triangular, and presents two surfaces, three borders, and an extremity or point.

The *anterior surface* is slightly convex, and traversed by three or four transverse lines or ridges indicating the points of union between the original pieces. The uppermost of these lines is always well marked, and the bone here often presents an angular prominence as though it had been fractured and the upper fragment bent backward. The *posterior surface* resembles the anterior, except that it is slightly concave from above downward.

The two *lateral borders* are thick, and present each seven articular pits for the reception of the extremities of the costal cartilages. The uppermost of these cavities is placed near the corresponding extremity of the border, is shallower than the rest, and triangular. The second is situated at the extremity of the superior transverse line, and separated from the preceding by a nearly straight edge at least an inch in length. Below the second the interspaces are lunated, and become rapidly smaller, until at the lower part of the border they form only narrow septa between the pits. The *superior border* is about two and a half inches in length, and is much the thickest part of the bone. It is well rounded, slightly lunated, and presents at each extremity a large depression, convex antero-posteriorly and concave transversely, for articulation with the clavicle.

The *point* or *extremity* of the bone generally remains cartilaginous to an advanced age, and is commonly called the *ensiform* or *xiphoid cartilage*. In size, shape, and direction, it varies remarkably in different individuals; sometimes it is bifurcated, sometimes perforated, often short and

blunt, and at other times long, thin, and narrow, bent to one side or curved in an anterior or posterior direction.

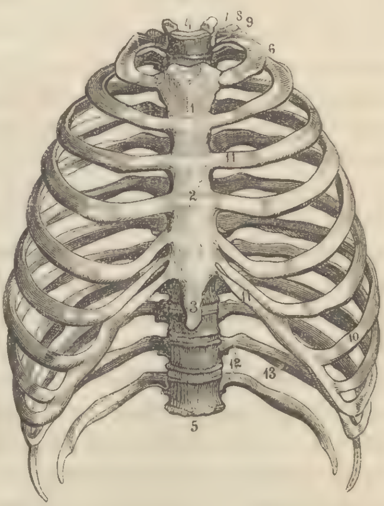
The sternum is composed of an open, spongy, or diploic substance, inclosed between two thin tables of compact tissue. It is developed from five points, forming as many separate pieces, which unite successively from below upward. Sometimes one or more of these pieces is developed from two lateral points, which, failing to unite, leave a vertical fissure in the middle lower part of the bone. The first ossific point is discovered about the sixth month of fœtal life, but the bone is not entirely completed by the union of the several pieces until the thirtieth or fortieth year of age. Union at the superior transverse line is the last to take place, and often entirely fails. The ensiform cartilage begins generally to ossify between the second and fifteenth year, but often remains unchanged until after middle life.

The sternum articulates with the clavicles and fourteen costal cartilages, seven on each side.

THE RIBS.

The Ribs (*costæ*) (Fig. 83), the long flat bars of the thoracic cage, are curved and somewhat twisted, and extend on each side from the dorsal vertebræ obliquely downward and forward toward the sternum, to whose lateral borders they are prolonged by the costal cartilages. They are twelve in number on each side, rarely varying in this respect; and in designating them numerically, the uppermost is always taken as the starting-point. The first seven are often termed the *true ribs*, and the last five the *false ribs*, because the former are provided with separate articular pits on the sternum. The last two, having their anterior extremities unattached, are sometimes called the *floating ribs*.

Fig. 83.



Front view of thorax. 1, 2, 3, three pieces of sternum; 4, 5, dorsal vertebræ; 6, first true rib; 7, its head; 8, neck; 9, tubercle; 10, seventh rib; 11, costal cartilages; 12, floating ribs; 13, groove for intercostal bloodvessels.

The ribs are arranged one above another, and incline obliquely from the spinal column, the degree of obliquity increasing successively from the first to the twelfth. In consequence of this, the intercostal spaces are broader in front than behind, especially the first. The length of the ribs increases from the first to the eighth, below which

it rapidly diminishes. Their breadth, which is always greatest anteriorly, gradually decreases from the first to the last. Their curvature is not regular, the posterior part of each representing the segment of a much smaller circle than the anterior, but in general it diminishes from the first to the twelfth. Besides this curvature, each rib has a slight twist, whose commencement posteriorly constitutes what is called the *angle* of the rib.

Each rib presents an external and an internal surface, two borders, and two extremities.

The *external surface* is irregularly convex, and, within one and a half or two inches of the posterior extremity, presents a transverse line corresponding to the angle, and, near the anterior extremity, a faintly-marked ridge indicating the attachment of the great serrate muscle. The *internal surface* is smooth and concave, and presents, near the inferior edge anteriorly, the continuation of the groove found upon the lower border.

The *superior border* is curved, thick, and rounded; upon it may be seen traces of an internal and an external lip or ridge. The *inferior border* has a greater curvature than the superior; is thin and sharp anteriorly, but grooved upon its inner aspect in the posterior two-thirds of its extent for the intercostal vessels and nerves. The two margins or lips of the groove give attachment to the superficial and deep intercostal muscles.

The *posterior extremity* of the rib is expanded into a small oval *head*, and is marked by a transverse ridge separating two smooth facets, of which the inferior is the larger, for articulation with the half pits upon the sides of the dorsal vertebræ. Just beyond the head, the rib is constricted into a *neck*, external to which is an eminence called the *tubercle*, which articulates with the extremity of the transverse process of the lower of the two vertebræ between which the head is placed. The *anterior extremity* of the rib is broad but not very thick, and grooved for the reception of the extremity of the costal cartilage.

The *first rib* is the shortest and broadest, and is curved only in the direction of its edges, its two surfaces being flat. As it is the shortest its curvature is the greatest. Its head is small, and presents but a single articular facet; its neck is long and cylindrical; its tubercle prominent and placed upon the edge of the bone; its anterior extremity very broad, and often joined to the sternum without any intervening cartilage. Its superior surface looks directly upward, and is crossed about the middle by an oblique ridge or eminence, which gives attachment to the anterior scalene muscle, and separates two superficial grooves for the subclavian artery and vein.

The *second rib* is nearly twice as long as the first, but not so broad; it is destitute of any twist, and presents upon its superior surface, which inclines a little outward and forward, a rough eminence for the attachment of the posterior scalene muscle.

The *eleventh* and *twelfth ribs* are the least curved and the narrowest of all. Their heads present but one articular surface; they have no groove, and their anterior extremities are free, sharp, and pointed. They differ from each other only in their length, the twelfth being much the shorter.

The ribs belong to the class of broad bones, and, therefore, have no medullary canal. The body of the bone is developed from a single point of ossification, which makes its appearance early in fœtal life, so that at birth nearly the whole length of the bone is complete. The articular facets of the head and tubercle are developed each from a single ossific point, which does not appear before the fifteenth or sixteenth year.

THE COSTAL CARTILAGES.

The Costal Cartilages eke out the ribs anteriorly, and add very greatly to their elasticity and mobility. Those of the true ribs reach the lateral borders of the sternum, those of the eighth, ninth, and tenth extend only to the lower border of the cartilage next above, while those of the eleventh and twelfth form only small tips to these bones. They increase in length successively from the first to the seventh, beyond which they gradually diminish. In size and shape they correspond very nearly to the ribs, but their direction is somewhat different; the first and second incline a very little downward, while all the others, with exception of the last one or two, ascend obliquely, the degree of obliquity increasing successively from above.

It is not unusual to find the cartilages ossified in old subjects, and this is more particularly true of the first.

GENERAL CHARACTERS OF THE THORAX.

The Thorax is situated at the upper part of the trunk, and, as before mentioned, incloses the principal organs of respiration and circulation. In situation, size, and structure, it holds a middle place between the other great cavities, the cranium and abdomen. Its size is subject to great variety in different individuals, but is generally greater in the male than in the female. In shape it resembles a cone flattened from before backward, with its base below and summit above, but in females accustomed to tight lacing it is more of a cylindroid figure.

Externally, the thorax presents an anterior, posterior, and two lateral surfaces. The *anterior surface*, formed by the sternum and costal cartilages, inclines obliquely from above downward and forward, and is more prominent in the female than in the male. The *posterior surface* is almost vertical in its direction, and presents upon each side of the spinal column a broad gutter, limited externally by the angles of the ribs, broader below than above, and occupied by the spinal muscles. The *lateral sur-*

faces are prominent and convex, and almost regularly oblique in their inclination from above downward and outward.

Internally, the thorax is also divisible into four surfaces, whose concavities correspond to the convexities of the external, except along the posterior wall, where the bodies of the vertebræ form an incomplete septum which divides the cavity, and forms upon each side a deep groove for the lodgment of the posterior rounded borders of the lungs.

The *base* of the thorax is cut, as it were, obliquely from before backward and downward, and presents a large, transversely elongated opening, whose circumference is formed by the last dorsal vertebra, the lower extremity of the sternum, the cartilages of the false ribs, and the bodies of the twelfth. In the recent state, the diaphragm closes this opening and forms the septum between the thoracic and abdominal cavities. In consequence of the obliquity of the base, the anterior wall of the thorax is much shorter than the posterior or the two lateral walls.

The *summit* of the thorax is truncated, and inclined from behind forward and a little downward. It presents a transversely oval opening, formed by the first rib upon each side, the superior margin of the sternum in front, and the body of the first dorsal vertebra behind. Through this opening pass the trachea, œsophagus, and numerous large bloodvessels and nerves. In the recent state, the plane of this opening does not limit the cavity of the thorax in this direction, for the lungs extend not less than two inches above the first rib.

THE SUPERIOR EXTREMITIES.

The two Superior Extremities are attached to the upper lateral parts of the thorax, and consist of the shoulder, arm, forearm, and hand.

The Shoulder is formed by two bones, the clavicle and scapula.

The Arm consists of but one bone, the humerus.

The Forearm is situated between the arm and hand, and contains two long bones, the ulna and radius, which are placed side by side, the former internal and the latter external.

The Hand consists of three parts, the carpus or wrist, the metacarpus, and the fingers.

THE CLAVICLE.

The Clavicle (Fig. 84), the shortest long bone in the body, forms the anterior part of the shoulder, and is situated at the upper front part of the thorax, extending nearly horizontally from the sternum to the scapula. Its size, which varies greatly in different individuals, is always relative to the muscular development of the corresponding limb. Its shape is very irregular, being triangular prismatic in the internal two-thirds of its extent, flattened from above downward toward its external extremity, and curved horizontally like the italic letter *f*.

The *superior surface* is almost subcutaneous, broader externally than internally, and marked in the latter situation by a slight elevation for the attachment of the sterno-cleido-mastoid muscle. The *inferior surface*, also broader externally, presents near the internal extremity a rough tubercle for the attachment of the costo-clavicular ligament, and, near the external, a similar one for the coraco-clavicular ligament. About the middle of this surface may also be seen the nutritious foramen and a longitudinal groove for the insertion of the subclavian muscle.

Fig. 84.

Under surface of clavicle of left side. 1, sternal end; 2, tubercle for attachment of sterno-clavicular ligament; 3, rough surface for origin of pectoral muscle; 4, roughness for attachment of coraco-clavicular ligament; 5, articular facet for acromion.

The *anterior border* is thick and convex internally, where it gives origin to the great pectoral muscle, and narrow and concave externally for the attachment of the deltoid. The *posterior border* is large, rounded, smooth, and concave internally, but externally narrow, convex, and rough, for the insertion of the trapezius muscle.

The *internal* or *sternal extremity* of the clavicle is prismatic, thick, and strong, and presents a triangular smooth surface below, concave antero-posteriorly, and convex transversely, for articulation with the sternum. The posterior inferior of the three corners of this extremity is very prominent. The *external* or *scapular extremity* is vertically flattened, and presents a narrow, oblong, and convex surface upon its border for articulation with the acromion process.

The structure of the clavicle is like that of long bones in general, but its medullary canal is very small. It is developed from a single ossific point, which makes its appearance between the thirtieth and fortieth day of fœtal life; and at birth the bone is almost completely formed.

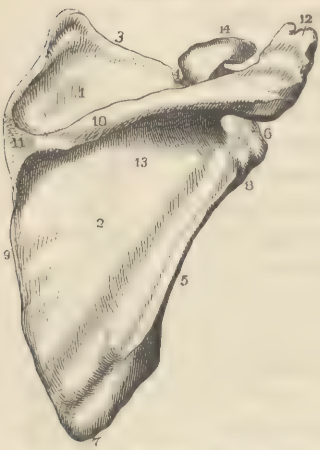
THE SCAPULA.

The Scapula or Shoulder Blade (Fig. 85) is a broad, thin, triangular bone, situated upon the upper part of the lateral and posterior surfaces of the thorax, and extending from the first to the seventh rib. It presents two surfaces, three borders, and three angles.

The *posterior* or *dorsal surface* is divided into two unequal parts by a vertically flattened triangular crest called the *spine of the scapula*, which commences about an inch above the middle of the posterior border of the bone in a smooth flattened surface over which the tendon of the trapezius muscle glides, crosses obliquely toward the anterior superior angle, over which it curves to form a broad shieldlike process named the

acromion. The spine does not, however, quite reach the angle, but forms a smooth concave border, which spreads out into the under surface of the acromion. Its posterior edge, called the *crest* of the spine, is quite thick, forming two well-marked lips, which are continuous with the margins of the acromion, and give attachment to the trapezius and deltoid muscles.

Fig. 85.



Posterior view of scapula. 1, supraspinous fossa; 2, infraspinous fossa; 3, superior border and angle; 4, suprascapular notch; 5, anterior or axillary margin; 6, glenoid cavity; 7, inferior angle; 8, origin of long head of triceps; 9, internal or vertebral border; 10, spine; 11, triangular facet made by trapezius; 12, acromion; 13, base of spine; 14, coracoid process.

The *acromion* is flat and irregularly quadrilateral, and stands forward and outward behind and above the shoulder joint. Its superficial surface looks upward, outward, and backward, and is rough, convex, and subcutaneous; its deep surface is smooth and concave, and looks downward and forward toward the joint. Its circumference is continuous with the two lips of the spine, and, at its superior internal edge, presents a transversely oval facet for articulation with the clavicle.

The dorsal surface above the spine is convex, but forms with the superior surface of the latter an angular fossa, *supraspinous fossa,* occupied in the recent state by the supraspinous muscle. Below the spine, the surface is also for the most part convex, and occupied by the infraspinous muscle; but, near the external border, it presents a broad well-marked longitudinal excavation, bounded upon its outer side by a narrow ridge, which gives origin at its middle to the small teres muscle, and spreads out below into an elongated flat surface for the attachment of the large teres muscle.

The *anterior* or *costal surface* of the scapula is concave, and constitutes the *subscapular fossa.* It is marked by several oblique ridges for the attachment of the subscapular muscle by which it is entirely occupied.

Of the three *borders* of the scapula, the *internal* or *vertebral* is the longest, thin, and somewhat curved, and gives attachment to muscles that draw the shoulder backward; it does not lie parallel with the spinal column, but inclines downward and outward. The *superior* is short and thin, and intersected by a deep notch, the *suprascapular notch*, which is converted into a foramen by a ligament, and gives passage to the suprascapular nerve. Externally to the notch the border is entirely occupied by the *coracoid process*, which stands up by a thick broad base, and, curving forward and outward, terminates in a rounded blunt extremity,

whose surface is smooth and concave beneath, where it overhangs the shoulder joint, and rough superiorly for the attachment of strong ligaments. The *external* or *axillary border* is thick and grooved. Its upper third gives attachment to the long head of the triceps muscle, and the middle and lower are embraced between the origins of the two teres and the subscapular muscles.

The *inferior angle* of the scapula is acute but rounded at the point. It is covered by the origin of the great teres muscle, and by the upper margin of the latissimus, which overlaps it and is often attached to it by a small fleshy slip. The *superior* is nearly a right angle, and presents upon its inner aspect a rough impression for the insertion of the elevator muscle. The *anterior angle* forms the *head* of the bone supported by a broad flattened *neck*, which embraces also the root of the coracoid process. It is thick, elongated from above downward, and excavated upon its outer and anterior aspect for articulation with the head of the humerus. The excavation, termed the *glenoid surface*, is very shallow, smooth, and oval in shape, the large end of the oval presenting below. In extent it is not more than one-third that of the head of the humerus, but is somewhat increased, in the recent state, by the long tendon of the biceps muscle which is attached around its borders.

The scapula articulates with the clavicle and humerus. It is developed from six points of ossification, two for the acromion, and one each for the body, the coracoid process, the internal border, and the inferior angle. Although one of the earliest bones in which ossification commences, it is not entirely completed until about the fifteenth year, when the coracoid process becomes joined to the body of the bone.

THE HUMERUS.

The Humerus or Arm Bone (Fig. 86) extends from the scapula to the bones of the forearm; and, belonging to the class of long bones, possesses a shaft and two extremities.

The *Shaft* is nearly cylindrical, slightly constricted at the middle, expanded laterally below, and twisted a little inward in its lower third. Its *anterior surface* is marked above by the *bicipital groove* which extends vertically downward but disappears before it reaches the middle of the bone. The groove, deep above where it passes between the two tuberosities, lodges the tendon of the long head of the biceps muscle, and its borders give attachment, the anterior to the great pectoral, and the posterior to the conjoined tendon of the latissimus and great teres muscles. The *deltoid eminence*, a rough, slightly raised V-shaped mark for the insertion of the deltoid muscle, is placed upon the outer aspect of this surface near the middle of the bone. Below the eminence the surface widens out and is occupied in the fresh state entirely by the anterior brachial muscle.

The *posterior surface*, owing to the torsion of the bone, looks a little inward above and outward below, and between these two divisions is a broad superficial groove which passes obliquely from within outward and downward and lodges the musculo-spiral artery and nerve.

The two *borders*, separating the anterior and posterior surfaces, are prominent only in the lower half of the bone, where they are known as the *condyloid ridges;* they are continuous with the condyles of the inferior extremity, are rough and give attachment to muscles, and to a strong intermuscular aponeurosis.

Fig. 86.

Right humerus, seen in front. 1, head of bone; 2, greater tuberosity, and 3, its anterior facet, for supraspinous muscle; 4, bicipital groove; 5, insertion of great pectoral muscle; 6, lesser tuberosity of humerus, for attachment of subscapular muscle; 7, neck of bone; 8, ridge for attachment of latissimus muscle; 9, triangular ridge for attachment of deltoid; 10, origin of anterior brachial muscle; 11, origin of extensor muscles of hand; 12, external condyle; 13, articular head for radius; 14, 15, trochlea for play of ulna; 16, internal condyle; 17, coronoid cavity.

The *Superior Extremity* of the humerus is the largest part of the bone, and presents a smooth, convex, articular eminence called the head of the humerus; a circular groove circumscribing the head, called the anatomical neck; a greater and smaller tuberosity; and a constriction supporting the whole, named the surgical neck.

The *head* of the bone (Fig. 86, $_1$) is placed obliquely to the axis of the shaft, smooth, and regularly convex, forming about one-third of a sphere, and, in the recent state, covered with cartilage for articulation with the scapula. The *anatomical neck* is merely a superficial furrow circumscribing the articular surface. The *tuberosities* are two rough eminences terminating the margins of the bicipital groove above, and placed upon a line with the shaft of the bone; the *greater* of the two is external and posterior, and marked by three small facets for the attachment of the supraspinous and infraspinous and small teres muscles; the *smaller*, more rounded and prominent, and situated anterior to the groove, gives insertion to the subscapular muscle. The *surgical neck* is the constricted part of the bone below the tuberosities.

The *Inferior Extremity* of the humerus is flattened from before backward, and curved a little forward. It presents two condyles, an articular surface, and two excavations called respectively the olecranoid and coronoid cavities.

The *internal and external condyles* (Fig. 86, $_{12, 16}$) are two rough prominences for the attachment of muscles and the lateral ligaments of the elbow joint; they

are situated upon the inner and outer aspect of the bone at the inferior termination of its lateral borders. The *internal* is much more prominent than the *external*, and inclines a little backward. Both are readily felt through the skin, and form important aids in the diagnosis of affections of the joint.

The *articular surface*, situated between and somewhat below the condyles, is smooth, transversely elongated, and divided by an oblique antero-posterior furrow into a trochlea and a small head, of which the former is internal and the latter external.

The *trochlea* is elongated and convex from before backward, but concave from side to side, presenting a genuine pulleylike surface, whose internal border, however, is much more prominent than the external. The greater sigmoid notch of the ulna corresponds to this surface. The *small head* is oblong in an antero-posterior direction, but regularly convex for articulation with the cuplike cavity of the radius.

The *coronoid* or *anterior sigmoid cavity* (Fig. 86, $_{17}$) is a small depression upon the anterior surface of the bone immediately above the trochlea. It is intended for the reception of the coronoid process of the ulna in flexion of the forearm.

The *olecranoid* or *posterior sigmoid cavity* is situated upon the posterior aspect of the bone directly opposite the preceding, from which it is separated by a thin bony septum, which is often incomplete. It is quite large, and receives the olecranon of the ulna in extension of the forearm.

The humerus is like all other long bones in the arrangement of its cancellated and compact substance. It is developed from seven ossific points, one each for the shaft, the head, the greater tuberosity, the condyles, the trochlea, and the head. The point for the shaft appears about the thirty-fifth or fortieth day of fœtal life, and at birth this part of the bone is almost completed, but the epiphyses are not entirely consolidated until the fifteenth or twentieth year.

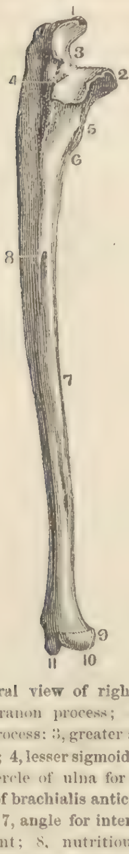
THE ULNA.

The Ulna (Fig. 87) is longer than the radius, along the inner side of which it is placed, larger above than below, slightly twisted upon its axis, and bent a little from behind forward. (In the description of the bones of the forearm, the limb is always considered as hanging by the side with the palm of the hand presenting forward.)

The *Shaft* of the bone decreases in size almost uniformly from above to within about two inches of the lower extremity, which is the narrowest part. It is triangular prismatic, and presents therefore three surfaces and three borders.

The *anterior surface* is smooth, vertically grooved for the origin of the flexor muscles, and perforated in its upper third by the nutritious foramen, which penetrates obliquely upward. The *posterior*, also smooth, but somewhat convex, is traversed throughout its whole length by a blunt ridge for the attachment of muscles, and, in its superior part, by an oblique line, which marks off a small triangular surface for the insertion of the anconeus muscle. The *internal* is smooth and somewhat depressed above, but rounded below, where it is almost subcutaneous.

Fig. 87.



Lateral view of right ulna. 1, olecranon process; 2, coronoid process; 3, greater sigmoid cavity; 4, lesser sigmoid cavity; 5, tubercle of ulna for attachment of brachialis anticus muscle; 6, 7, angle for interosseous ligament; 8, nutritious foramen; 9, articular face for radius; 10, head of ulna; 11, styloid process.

The three *borders* separating the surfaces are all more prominent above than below; the *external* is the sharpest, presents toward the radius, and gives attachment to the interosseous membrane.

The *Upper Extremity* of the ulna is the largest part of the bone, and presents two processes called the olecranon and coronoid, and two articular excavations named the greater and lesser sigmoid notches.

The *olecranon* (Fig. 87, $_1$) is situated superiorly and on a line with the shaft of the bone. Its anterior surface forms a part of the greater sigmoid notch, is smooth and concave, and traversed by a rounded vertical ridge, terminating above in a pointed extremity, which is received into the olecranoid cavity of the humerus. Its posterior surface is irregularly convex, smooth above, and rough below for the insertion of the triceps muscle.

The *coronoid process* (Fig. 87, $_2$) is situated below and anterior to the olecranon, from which it is separated by the articular cavity. It is vertically flattened, has a broad base, and a sharp free edge, and spreads out below into a rough depression or tubercle for the insertion of the anterior brachial muscle. Its superior surface forms the lower half of the greater sigmoid notch, and upon its outer border is a smooth, shallow, antero-posterior excavation called the *smaller sigmoid notch*, for articulation with the circumference of the head of the radius.

The *greater sigmoid notch* (Fig. 87, $_3$) is formed upon the anterior surface of the olecranon and upper surface of the coronoid process. It is smooth, concave from above downward, resembling the letter C in its

profile, and slightly convex from side to side to correspond with the trochlea of the humerus, with which it articulates. It is marked at the bottom by a transverse line, indicating the junction of the olecranon with the shaft.

The *Lower Extremity* of the ulna is small, and terminates in a smooth rounded head, which looks a little outward for articulation with the cavity formed upon the inner border of the lower extremity of the radius and the upper surface of a plate of fibro-cartilage attached to the latter. From the inner side of the head, the *styloid process*, a small cylindrical eminence, nearly half an inch in length, projects vertically downward, and gives attachment to the internal lateral ligament of the wrist joint.

The ulna articulates with the humerus and radius above to constitute the elbow joint, and below with the radius and triangular cartilage. It is developed from three points of ossification, one for the shaft and one for each extremity. The former shows itself about the forty-fifth day, but the latter do not appear before the fifth or sixth year. Complete consolidation of the olecranon and head with the shaft does not take place until the eighteenth or twentieth year.

Fig. 88.

Posterior view of right radius. 1, head of bone; 2, annular articulating surface for ulna; 3, neck; 4, tubercle; 5, nutritious foramen; 6, insertion of short supinator muscle; 7, internal edge for attachment of interosseous ligament; 8, articular face for ulna; 9, carpal face of bone; 10, styloid process; 11, grooves made by extensor tendons in their course to the hand; 12, external surface of radius.

THE RADIUS.

The Radius is situated externally to the ulna, with which it is articulated above and below, a broad interval, called the *interosseous space*, separating them throughout the rest of their extent. It is a little shorter than the ulna, and unlike the latter is larger below than above.

The *Shaft* is three-sided, slightly curved outward, and gradually increases in size from above downward. The *anterior surface* looks a little inward as well as forward, and is perforated in its upper third by the nutritious foramen. At its termination above, within about an inch of the head of the bone, is a large oval eminence, called the *bicipital tuberosity*, whose posterior border is rough for the insertion of the tendon of the biceps muscle, and its anterior smooth for the gliding of the latter. The posterior surface is convex above and below, but depressed at its middle. The *external* is rounded and smooth, except near its middle, where there is a roughness

for the insertion of the round pronator muscle. Of the three *borders*, the anterior and posterior are blunt and rounded, but the internal is well marked, and directed toward the corresponding border of the ulna for the attachment of the interosseous fibrous membrane.

The *Superior Extremity* or *Head* (Fig. 88, 1) represents a short oblique section of a cylinder, whose base looks upward. The latter is smooth and slightly concave, and articulates with the smaller head of the humerus. Its circumference is circular, broadest upon its inner aspect, smooth and convex throughout, and is received into the ring formed by the annular ligament and the smaller sigmoid notch of the ulna. Between the head and bicipital tubercle is a slight constriction or *neck*, which is bent a little outward.

The *Inferior Extremity* is broad and thick, and presents upon its lower aspect a large, concave, triangular articular surface, divided by a very slight antero-posterior ridge into two unequal parts, of which the external corresponds to the scaphoid, and the internal to the semilunar bone. The circumference of the articular surface is marked *anteriorly* by some slight inequalities for the attachment of the anterior ligament of the joint; *posteriorly*, by several vertical and oblique grooves for the tendons of the extensor muscles of the fingers and thumb; *internally*, by a small antero-posterior excavation, called the *semilunar cavity*, for articulation with the side of the head of the ulna; and *externally*, by a short, thick, angular eminence, named the *styloid process*, to the extremity of which the external lateral ligament of the joint is attached.

The radius articulates with the humerus, the ulna, and the carpus. Its structure is said to differ from that of the ulna in possessing a greater degree of brittleness, especially in the lower third of the bone, where fractures are most apt to occur. It is developed from three points of ossification, namely, one for each extremity, and one for the shaft; the last precedes that of the ulna by two or three days, appearing from the thirty-fifth to the fortieth day. The bone is not completed, however, before the ninth or tenth year.

THE CARPUS.

The Carpus or Wrist (Figs. 89 and 90) is situated between the forearm and the metacarpus, and consists of eight small short irregular bones closely articulated. It is flattened from before backward, quadrilateral, transversely elongated, and presents two surfaces and four borders. (In studying the different bones of the hand, the palmar surface is considered as presenting forward, although the natural position is midway between pronation and supination.)

The *anterior surface* is transversely concave for the lodgment of the tendons of the flexor muscles of the fingers, the lateral terminations of the

concavity being formed, in a great measure, by two bony eminences on each side, which give attachment to the annular ligament. The *posterior surface* is slightly convex, and marked only by the lines indicating the union of the several bones.

The *superior border* is convex, smooth, and transversely elongated, and corresponds to the lower extremity of the radius. The *inferior border*, longer than the superior, is irregular, and presents five smooth facets for articulation with the five metacarpal bones. The *external* or *radial*, and the *internal* or *ulnar border*, are each short and uneven, and give attachment to ligaments.

When in position the eight bones form two transverse rows, each consisting of four bones, named as follows:

First or upper row, commencing at the radial border . . .	1. The scaphoid. 2. The semilunar. 3. The cuneiform. 4. The pisiform.
Second or lower row, commencing at the radial border . .	1. The trapezium. 2. The trapezoid. 3. The magnum. 4. The unciform.

Without describing in detail all the surfaces, generally six in number, which each bone presents, the prominent features of the carpal bones may be briefly stated.

The **Scaphoid** (Fig. 89, $_1$) is the largest bone of the first or upper row, as the magnum is of the second or lower row. The scaphoid is convex on one side, concave on the other, articulates with the radius by its superior surface, with the trapezium and trapezoid by its inferior, and with the semilunar and magnum by its internal surface, and gives attachment to ligaments on its external, anterior, and posterior surfaces.

The **Semilunar** (Fig. 89, $_2$), also concavo-convex, articulates with the radius by its superior surface, with the cuneiform by its internal, with the magnum and unciform by its inferior, and with the scaphoid by its external surface, and gives ligamentous attachment on its anterior and posterior surfaces.

The **Cuneiform** (Fig. 89, $_3$), irregularly wedge-shaped, articulates with the unciform of the second row by its inferior surface, with the semilunar by its external, and with the pisiform by its anterior surface. Superiorly, the bone is in contact with the interarticular fibro-cartilage of the wrist. The internal and posterior surfaces give attachment to ligaments.

The **Pisiform** (Fig. 89, 4), small and rounded, at the inner extremity of the carpus, articulates only with the anterior surface of the cuneiform. It affords attachment to the annular ligament of the wrist and to muscles.

The **Trapezium** (Fig. 89, 5), irregular in shape, occupies the outer portion of the second row, and articulates with the trapezoid and the second metacarpal bone by its internal surface, with the scaphoid by its superior, and with the first metacarpal bone by its inferior surface. The external, anterior, and posterior surfaces afford ligamentous attachment, the anterior being deeply grooved for the tendon of the radio-carpal flexor, and presenting a ridge for the annular ligament.

The **Trapezoid** (Fig. 89, 6) articulates with the scaphoid by its superior surface, with the second metacarpal bone by its inferior, with the trapezium by its external, and with the magnum by its internal surface. The anterior and posterior surfaces are for ligamentous attachment.

The **Magnum** (Fig. 89, 7), the largest of the carpal bones, with a convex head and irregular base, articulates with the scaphoid and semilunar by its superior surface or head in the concavity formed by those bones, with the second, third, and fourth metacarpal bones by its inferior, with the trapezoid by its external, and with the unciform by its internal surface. The anterior and posterior surfaces are rough for the attachment of ligaments.

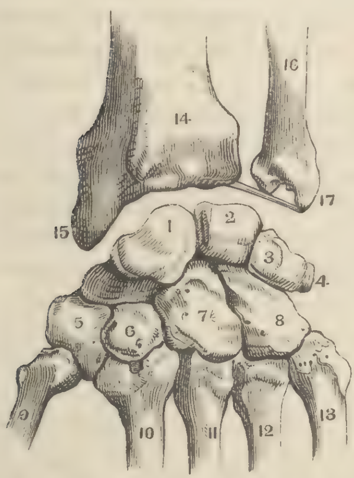
The **Unciform** (Fig. 89, 8), a wedge-shaped bone at the internal lower extremity of the carpus, presents a hooklike process from its anterior surface for the attachment of the annular ligament. It articulates with the magnum by its external surface, with the cuneiform by its internal, with the semilunar by its superior, and with the fourth and fifth metacarpal by its inferior surface. The anterior surface is grooved externally for the passage of flexor tendons to the palm of the hand. The posterior surface is rough for the attachment of ligaments.

Development of the Carpal Bones.—The carpus is entirely cartilaginous at birth, and does not usually begin to ossify until about the end of the first year, when a single ossific point appears in the magnum. This is very soon succeeded by a point in the unciform ; next, during the third year, in the cuneiform ; then, during the fifth year, in the trapezium and semilunar ; and, about the eighth year, in the scaphoid and trapezoid. The pisiform is the latest of all the bones of the skeleton in ossifying, no bony matter being deposited in it before the twelfth year.

THE METACARPUS.

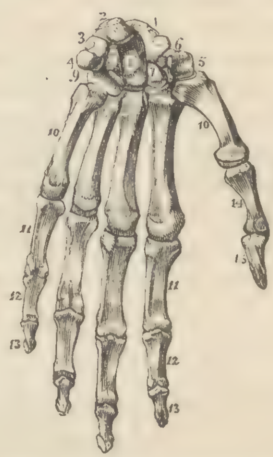
The Metacarpus (Figs. 89 and 90) is a sort of osseous grating situated between the carpus and the fingers, and forming the central square part of the hand. It is quadrilateral in shape, broader below than above, concave in front, convex behind, and consists of five separate bones, designated numerically, beginning with the outer one. With the exception of the first, they are placed nearly parallel side by side, and joined together at their two extremities, but separated in the middle by spaces which lodge the interosseous muscles. They belong to the class of long bones, and consist each of a body and two extremities.

Fig. 89.



Posterior or dorsal surface of left wrist and contiguous bones. 1, scaphoid bone; 2, semilunar; 3, cuneiform; 4, pisiform; 5, trapezium; 6, trapezoid; 7, magnum; 8, unciform; 9, metacarpal bone of thumb; 10, metacarpal bone of index finger; 11, 12, and 13, third, fourth, and fifth metacarpal bones; 14, radius; 15, styloid process of radius; 16, ulna; 17, styloid process of ulna.

Fig. 90.



Hand viewed upon its anterior or palmar aspect. 1, scaphoid bone; 2, semilunar; 3, cuneiform; 4, pisiform; 5, trapezium; 6, groove in trapezium that lodges tendon of radiocarpal flexor; 7, trapezoid; 8, magnum; 9, unciform; 10, 10, five metacarpal bones; 11, 11, first row of phalanges; 12, 12, second row; 13, 13, third row, or ungual phalanges; 14, first phalanx of thumb; 15, second and last phalanx of thumb.

Their bodies are triangular prismatic, and curved so as to present a concavity in front and a corresponding convexity behind. The *upper extremity* of each is thick and wedge-shaped, broader behind than before, and presents a superior surface for articulation with the carpus, two lateral surfaces for contact with the adjoining bones, and an anterior and a posterior rough surface for the attachment of ligaments. The *lower extremity* or *head* is oblong from before backward, smooth, convex, flattened laterally, and of greater extent before than behind; its lateral surfaces are rough for ligamentous attachment.

The *first metacarpal bone* (Fig. 89, 9) belongs to the thumb, and is placed upon a plane somewhat anterior to the others, from which it diverges outwardly, leaving a large triangular-shaped interosseous space between it and the next. Its separate position has reference to the opposition of the thumb to the rest of the hand. It is the shortest and thickest of the group; its body is somewhat flattened from before backward; and its carpal extremity is smooth, concave from before backward, and convex transversely, to conform to the surface upon the trapezium, which is concave and convex in the reverse order.

The *second* and *third metacarpal bones* (Fig. 89, 10, 11) are distinguished from the others by their greater length, and from each other by the greater size of the third. They may be known also by their carpal extremities; that of the second presents two articular surfaces above, one for the trapezium, and a much larger one for the trapezoid, and but one lateral facet, while the third has two of the latter and but one above for the magnum.

The *fourth* and *fifth metacarpal bones* (Fig. 89, 12, 13) are much shorter and smaller than the second and third. The fourth has two articular surfaces above for the magnum and unciform, two circular facets for contact with the third, and one for the fifth metacarpal bone. The fifth joins the unciform by a concave surface, and the fourth by a single plane lateral facet; upon its ulnar side it presents a tubercle for the insertion of the ulnar extensor muscle of the hand.

Development of the Metacarpal Bones.—The metacarpal bones are each developed from one principal point of ossification, which makes its appearance in the body of the bone about the fortieth or fiftieth day. About the third year an epiphysary point appears upon the lower end of each (excepting that of the thumb), which becomes united to the body toward the twentieth year. The metacarpal bone of the thumb has also an epiphysis superadded upon its superior or carpal extremity.

THE FINGERS.

The Fingers (Fig. 90) are distinguished from each other numerically, counting from the radial border. They are often referred to, however, by their ordinary names, as thumb, index finger, middle finger, ring finger, and little finger.

Each finger, excepting the first, consists of three bones called *phalanges*, which are placed in a line with each other, and diminish in size successively from the first to the third. The thumb has but two. Like other long bones, they have a body and two extremities.

The *first phalanges* (Fig. 90, 11, 14), five in number, are each semicylindrical, and curved so as to present a slight concavity in front, where they are also grooved lengthwise for the lodgment of the extensor ten-

dons of the fingers. A rough edge on each side of this groove gives attachment to the fibrous sheath which confines the tendon. Posteriorly, they are convex and smooth. The superior extremities are transversely oval, and slightly excavated for articulation with the heads of the metacarpal bones. The inferior extremities, smaller than the superior, present a smooth pulleylike surface, prolonged farther upon the anterior than the posterior aspect, for articulation with the second row, and a rough depression on each side for the attachment of ligaments.

The *second phalanges* (Fig. 90, $_{12, 15}$), four in number (the second of the thumb belonging to the third class), are shorter and smaller than the first, but not unlike them in shape. The bodies are curved forward, convex behind, concave and grooved in front. The superior extremities, transversely elongated, present two small articular excavations separated by an antero-posterior ridge, corresponding to the pulleylike surfaces upon the distal extremities of the preceding group. The inferior extremities are like those of the first row, only smaller.

The *third* or *last phalanges* (Fig. 90, $_{13}$), five in number, called also *ungual phalanges*, because they support the nails, are much shorter than the others, of a pyramidal form, flattened from before backward, and constricted at the middle. They are convex behind, nearly plane in front, and present a rough margin leading to the summit. Their bases or superior extremities are elongated transversely, and present articular surfaces in every respect resembling those of the second row. The ungual phalanx of the thumb is the largest of the series.

Development of the Fingers.—The phalanges are also developed from one principal and one epiphysary point, the former appearing in the body of each about the same time as in the metacarpal bones. The epiphysary point is developed upon the upper extremity of each (as in the metacarpal bone of the thumb) about the third or fourth year in the first row, and a year later in the others. Entire union does not take place before the eighteenth or twentieth year.

THE INFERIOR EXTREMITIES.

The skeleton of the inferior extremities presents many very striking analogies to that of the superior; it is, indeed, constructed upon the same general plan with certain modifications having reference to the different functions of the limb. Like the latter, it consists of four divisions, namely, the hip or haunch, the thigh, the leg, and the foot, corresponding to the shoulder, arm, etc.

The first of these divisions, the Hip, unlike its counterpart, the shoulder, is composed, in the adult, of but one bone, the innominate, which, however, in the young subject consists of three parts.

The Thigh consists of but one bone, the Femur, in connection with which the Patella, a sesamoid bone developed in the common tendon of the extensor muscles of the leg, may also be studied.

The Leg, like the forearm, consists of two bones, the tibia and fibula, which, though placed side by side, are joined only at their extremities.

The Foot, the fourth division of the inferior extremity, consists of twenty-six separate bones joined together in such a manner as to form a firm but elastic base, which supports the weight of the body in an erect posture. It varies in size in different individuals, and in general is smaller in the female than in the male. It is elongated from before backward, flattened from above downward, broad anteriorly, thick and narrow posteriorly, convex above, and concave below. The axis of the foot, unlike that of its analogue of the upper extremity, the hand, represents the segment of a circle, whose convexity presents upward to receive the weight of the body. Like the hand, it is divided into three parts, namely: the tarsus, metatarsus, and toes.

THE INNOMINATE BONE.

The Innominate or Hip Bones (Figs. 91 and 92) form the lateral and anterior walls of the pelvis. They belong to the class of broad bones, of which they are the largest in the body, and most irregular.

In the young subject each bone consists of three parts, called respectively the ilium, pubis, and ischium, the point of union being the large cup-shaped depression called the acetabulum, situated upon the middle of the outer surface for articulation with the head of the thigh bone; for convenience of study and reference, it is still the custom to make this distinction in describing the complete bone.

The **Ilium** (Figs. 91 and 92) forms the upper and lateral flaring portion of the pelvic wall, and is the largest and broadest of the three pieces. It is triangular and presents two surfaces, three borders, and three angles.

The *internal surface* is crossed from behind forward by a well-defined ridge called the *ilio-pectineal line*, which is continued upon the pubis and forms the lateral border of the brim of the pelvis. Above this line the surface forms a large shallow concavity named the *iliac fossa*, which is occupied by the iliac muscle. Below the posterior extremity of the line is the large ear-shaped or *auricular surface* for articulation with the sacrum, and behind this a space about an inch and a half wide marked by numerous irregularities for the attachment of the sacro-iliac ligaments. In front of the auricular surface the bone forms a part of the pelvic canal, and is smooth and slightly concave.

The *external* or *dorsal surface* is convex before, and slightly concave behind. It is traversed in an antero-posterior direction by two faintly marked curved ridges, called the *superior* and *inferior curved lines*,

which, commencing respectively at the superior and inferior spinous processes of the anterior margin, arch upward and terminate upon the inferior border of the bone behind. The space between these two lines is occupied by the attachment of the small gluteal muscle, and that between the inferior one and the acetabulum by the capsular ligament. Upon the upper posterior part of the dorsum may be observed another but much shorter rough line, directed from above downward, and marking off a narrow, uneven surface, not more than an inch in length, for the attachment of a part of the great gluteal muscle. The entire space in front of this and above the superior curved line gives attachment to the middle gluteal muscle. Below the inferior curved line is a nutritious foramen.

Fig. 91.

Inner view of left hip or innominate bone, dotted line indicating its division into three parts, ilium, ischium, and pubis. 1, iliac fossa; 2, body of pubis; 3, plane of ischium; 4, crest of ilium; 5, 6, anterior superior, and anterior inferior spinous processes; 7, 8, posterior superior, and posterior inferior spinous processes; 9, articular surface for sacrum; 10, rough surface for attachment of ligaments; 11, symphyses; 12, horizontal, and 13, descending ramus; 14, upper border of body; 15, spine of pubis; 16, pectineal line; 17, ramus of ischium; 18, tuberosity; 19, spine of ischium; 20, ilio-pubic eminence; 21, obturator foramen; 22, great sciatic notch; 23, lesser sciatic notch.

Fig. 92.

Outer view of left hip or innominate bone. 1, dorsal surface of ilium; 2, body of ischium; 3, body of pubis; 4, crest of ilium; 5, 6, superior and inferior curved lines; 7, surface of great gluteal muscle; 8, 9, anterior superior, and anterior inferior spinous processes; 10, 11, posterior superior, and posterior inferior spinous processes; 12, spine of ischium; 13, great sciatic notch; 14, lesser sciatic notch; 15, tuberosity of ischium; 16, ramus of ischium; 17, horizontal ramus of pubis; 18, descending ramus; 19, acetabulum; 20, obturator foramen.

The *superior border* or *crest of the ilium* is nearly semicircular, and, when looked at from above, appears bent somewhat like the italic letter *ſ*. It is thick, but narrower at the middle than at the two extremities, and it is divided into an internal and an external lip, and an interspace or middle lip for the attachment of the three broad lateral muscles of the abdomen.

The *posterior border* looks downward as well as backward. It commences at the posterior termination of the crest by an eminence called the *superior posterior spinous process*, below which is a slight notch, and then another eminence, the *inferior posterior spinous process*, and, lower still, a much larger excavation which forms a part of the *great sacro-ischiatic notch.*

The *anterior border* commences at the anterior extremity of the crest, and forms with it a rounded angle called the *superior anterior spinous process;* beneath which is a large superficial notch terminating in another eminence, denominated the *inferior anterior spinous process;* below the last is a smaller but deeper notch, which is bounded inferiorly by a large rounded eminence, marking the union between the pubis and ilium, and hence called the *ilio-pectineal eminence.*

The anterior inferior angle of the ilium joins the pubis and ischium, and constitutes nearly two-fifths of the acetabulum.

The **Pubis** (Figs. 91 and 92) lies in front of the ilium and extends inward to unite with its fellow of the opposite side at the symphysis. It is divided into a body and ramus.

The *Body* is horizontal, quite thick where it joins the ilium and ischium, but diminishes rapidly toward its internal extremity. It presents three well-defined surfaces, of which the *superior* gives origin to the pectineus muscle ; the *posterior*, smooth and rounded, forms part of the pelvic canal ; and the *anterior* is short and narrow. The three borders separating these surfaces are, a *posterior*, which is the continuation of the ilio-pectineal line, and terminates within less than an inch of the internal extremity of the bone in a conical eminence known as the *spinous process* of the pubis ; an *anterior*, extending from the spinous process to the border of the acetabulum ; and an *inferior*, which forms the superior border of the obturator foramen, and is grooved obliquely from within outward and forward for the obturator vessels and nerve.

The *external extremity* unites with the ilium and ischium, and forms about one-fifth of the articular cavity. The *internal extremity* is flattened from within outward, and joins the opposite bone by a vertically oval facet which is rough for the attachment of the intervening fibro-cartilage. The short border between the spinous process and the symphysis is sometimes denominated the *crest of the pubis.*

The *Ramus* is a prolongation of the internal extremity from which it extends downward to join the ramus of the ischium. It is short, flattened from before backward, smooth behind where it is in contact with the urinary bladder, and rough in front for muscular attachment. Its external border is sharp and continuous with the lower border of the body ; the internal is thicker, and forms part of the pubic arch.

The **Ischium** (Figs. 91 and 92) is placed below the ilium and pubis, and consists of a body and ramus united so as to form below a thick, rough, rounded angle, called the *tuberosity*.

The *Body* is situated behind; it is short, thick, and triangular, and presents three surfaces and three borders.

The *internal surface* is smooth and concave, and forms part of the pelvic canal; the *external* is rough for the attachment of muscles; and the *posterior* is convex and irregular, and gives attachment upon the tuberosity to the great sacro-ischiatic ligament.

The *anterior border* is thick and forms part of the margin of the obturator foramen; the *external* is rounded and depressed superiorly for the origin of the semimembranous muscle; the *internal* is divided into two parts by a prominent pointed process, the *spinous process of the ischium*, which is directed backward and outward, and gives insertion to the smaller sacro-ischiatic ligament. Above this process the margin is sharp and well defined, and forms with the inferior border of the ilium the *great sacro-ischiatic notch*, which is converted into a foramen in the recent state by the ligament already mentioned. Below the process the margin presents a small, smooth, and rounded notch, the *small ischiatic notch*, upon which the tendon of the internal obturator muscle glides as upon a pulley; this is also converted into a foramen in the recent state, and, beside the tendon just mentioned, transmits the internal pudic artery, vein, and nerve.

The *superior extremity* joins the ilium and the pubis, and forms about two-fifths of the acetabulum; the *inferior* is continuous with the ramus at the tuberosity.

The *Ramus* is much smaller than the body, and directed upward and inward to join the corresponding process of the pubis. It is triangular prismatic, rough anteriorly for muscular attachment, smooth posteriorly, and rounded and uneven internally, where it forms with the ramus of the pubis one of the sides of the pubic arch. Its external border is sharp for the attachment of the obturator membrane; the two others present nothing of special interest.

The *acetabulum*, or as it is also called, the *cotyloid cavity*, is situated upon the external surface of the innominate bone, a little below its middle, at the junction of the three pieces. Each division of the bone contributes to its formation, the ilium nearly two-fifths, the pubis one-fifth, and the ischium a little more than two-fifths. Its nearly hemispherical cavity is about two inches in diameter and one in depth, and looks outward, forward, and downward. Its border is prominent and sharp, especially above, and, in the recent state, is made still more projecting by a ring of fibro-cartilage which rests upon it. In front, this border presents a deep notch, which is formed into a foramen by a transverse ligament, and gives passage to the vessels of the joint. At the

bottom of the cavity there is a rough depression, which is continuous with the notch for the attachment of the round ligament of the joint, and the lodgment of certain little masses of fat.

The *obturator* or *thyroid foramen* is the large opening formed by the pubis above and the two parts of the ischium below. It is vertically oval in shape in the male, but triangular in the female. It is nearly closed in the recent state by a strong fibrous membrane. Its margin is thin and sharp, and grooved superiorly for the obturator vessels and nerve.

The innominate bone articulates with its fellow of the opposite side, with the sacrum, and with the femur. Like other broad bones, it consists of two laminæ of compact tissue inclosing a diploic or spongy tissue. In some places this latter constituent is almost entirely wanting, and the two laminæ come in contact; it is most abundant around the acetabulum and along the crest of the ilium.

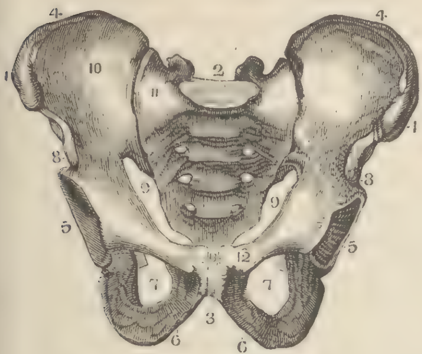
The innominate bone is developed from three principal ossific points corresponding to the three pieces. The first appears in the ilium about the fiftieth or sixtieth day, the second in the body of the ischium toward the third month, and the third in the horizontal portion or body of the pubis during the fourth or fifth month. These unite together at the acetabulum about the thirteenth or fourteenth year, a small Y-shaped piece of bone being developed separately between the three just before this period. At birth, the crest of the ilium, the acetabulum, the tuberosity and ramus of the ischium, and the inner extremity of the pubis are almost entirely cartilaginous. About the thirteenth or fourteenth year four epiphyses begin to show themselves upon the different parts of the bone, one for the whole length of the crest of the ilium, one for the anterior inferior iliac spine, one for the broad surface of the tuberosity of the ischium, and one for the inner extremity of the pubis. These are all united about the twentieth, or sometimes not until the twenty-fifth year.

THE PELVIS.

The Bony Pelvis (Figs. 93 and 94) is a large, irregular, broad ring forming the inferior part of the skeleton of the trunk, being connected on the one hand with the spinal column which rests upon the middle of its superior margin behind, and, on the other, with the two thigh bones which articulate with its sides. It is composed of four separate bones, the sacrum, the coccyx, and the two innominate bones, to which some anatomists add also the last lumbar vertebra. It is proportionally smaller in the child than in the adult, and, owing to characteristic differences in its separate pieces, is larger and more expanded in the female than in the male. (For its obstetric characters, the student is referred to works upon midwifery.)

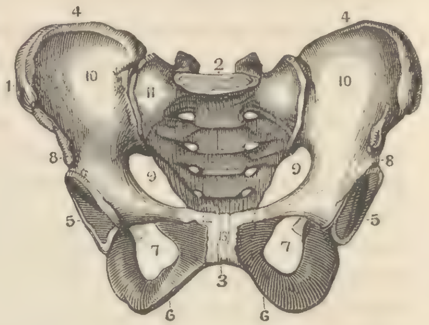
Considered as an irregular hollow cone with its base looking upward and forward, and its summit truncated and bent forward, the pelvis has an external and an internal surface, which should be separately considered.

Fig. 93.



MALE PELVIS.

Fig. 94.



FEMALE PELVIS.

The male and female pelvis are compared in Figs. 93 and 94. 1, anterior superior spinous process of ilium; 2, base of sacrum; 3, angle of pubis; 4, crest of ilium; 5, acetabulum; 6, ramus of ischium; 7, thyroid or obturator foramen; 8, anterior inferior spinous process of ilium; 9, 9, superior strait; 10 iliac fossa; 11, sacro-iliac symphysis; 12, spine of pubis; 13, symphysis of pubes.

The *External Surface* is marked *in front*, in the middle line, by the union of the two pubic bones forming the *pubic symphysis*, which is always longer in its vertical direction in the male than in the female, measuring one and three-quarter inches in the former, and one and a quarter in the latter. Below the symphysis the branches of the pubes and ischia diverge to form the *arch of the pubis*, which is larger in the female than in the male. Outside of the arch on each side is the obturator foramen, vertically oval in the male, but larger and triangular in the female. *Posteriorly*, in the median line, is the vertical spine of the sacrum terminating below in a bifurcation, which forms the two sides of the lower orifice of the spinal canal. Outside of the spine are the sacral grooves with the sacral foramina, and, still more externally, the projecting border of the ilium. *Laterally*, may be observed the broad uneven dorsal surface of the ilium, with its semicircular lines and nutritious foramen, the acetabulum, and the sacro-ischiatic notches. The notches, when the ligaments that extend from the side of the sacrum and coccyx to the tuberosity and spine of the ischium are in place, constitute the greater and smaller sacro-ischiatic foramina.

The *Internal Surface* of the pelvis is divided into two parts by the ilio-pectineal lines and the promontory of the sacrum. The superior division is called the *greater* or *false*, and the inferior the *smaller* or *true pelvis*.

The *greater* or *false pelvis* is formed behind by the last lumbar vertebra, and laterally by the internal concave surfaces of the iliac bones, which

are more flaring and less concave in the female than in the male. The inclosed space is the lower part of the abdominal cavity.

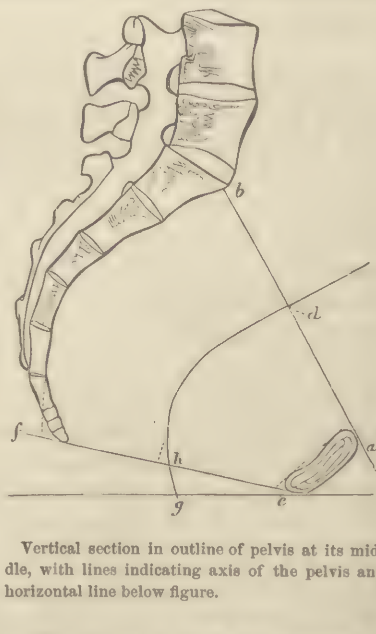
The *smaller* or *true pelvis* is a curved cylindrical canal, whose two extremities are cut, as it were, in such a manner that the posterior is much longer than the lateral walls, and the anterior less than either. The superior is called the inlet or superior strait, and the inferior the outlet or inferior strait of the pelvis. The intervening cavity is sometimes termed the pelvic excavation.

The *superior strait* or brim of the pelvis is an irregular circle in the male and a transverse oval in the female. It is defined, behind, by the promontory, and expanded wings of the sacrum; laterally, by the ilio-pectineal line; and, in front, by the crest and symphysis of the pubis. The opening is smaller in the male than in the female. In the latter, the *antero-posterior diameter*, extending from the pubic symphysis to the anterior edge of the base of the sacrum, is about four inches; the *transverse* about five; and the *oblique*, reaching from the acetabulum of either side to the sacro-iliac junction of the opposite side, about four and a half inches. In the living subject the transverse diameter is shortened nearly an inch by the encroachment of the iliac muscles.

Fig. 95.

Vertical section of female pelvis made through symphysis of pubis and middle of sacrum, showing left lateral half. 1, symphysis of pubis; 2, base of sacrum; 3, coccyx; 4, anterior superior spine of ilium; 5, tuberosity of ischium; 6, spine of ischium; 7, ilio-pectineal line; 8, spinous process of pubis; 9, crest of pubis; 10, superior, 11, inferior, inclined plane; 12, great, 13, small, sacro-ischiatic notch.

Fig. 96.



Vertical section in outline of pelvis at its middle, with lines indicating axis of the pelvis and horizontal line below figure.

The *plane* or level of the superior strait (Figs. 95 and 96) is not horizontal, but forms, with the axis of the trunk of the body, an angle of

145°. The *axis* of this strait (Fig. 96), a line drawn perpendicular to the centre of the plane, if continued upward, would pass through the abdominal wall at the umbilicus, and, if extended downward, would strike the apex of the sacrum or the first bone of the coccyx.

The *inferior strait* of the pelvis is nearly circular, but deeply notched on each side and in front. The lateral notches are the sacro-ischiatic which are bridged across, in the recent state, by the sacro-ischiatic ligaments; the anterior is the pubic arch, which is broader and less angular in the female than in the male. The diameters of this strait in the female are: 1, the *antero-posterior*, extending from the lower margin of the pubic symphysis to the point of the coccyx, measuring five inches, but capable of being increased at least half an inch in the living subject by the mobility of the last bone; 2, the *transverse*, extending between the tuberosities of the ischia, also four inches; 3, the *oblique*, measuring four inches, from the junction of the ramus of the ischium and pubis to the middle of the sacro-ischiatic ligament of the opposite side, and susceptible of a slight increase in the living subject. The *plane* of the inferior strait of the dry pelvis is marked by a line, drawn from the point of the coccyx to the lower margin of the pubic symphysis. Its course is forward and a little downward, the summit of the coccyx, in the natural position, being a little higher than the inferior edge of the symphysis.

The pelvic cavity is bounded behind by the anterior surface of the sacrum and coccyx, laterally by the ischia, and anteriorly by the two pubic bones and their symphysis. The *posterior wall* is about four inches and a half in height, and concave, the concavity being, probably, a little greater in the male than in the female; upon it may be seen the transverse lines and foramina of the sacrum, and the transverse divisions between the separate pieces of the coccyx. The *anterior wall* is smooth, and slightly convex from above downward; it varies from one and a quarter to one and two-third inches in height in the median line. The *lateral walls* are formed by the inner surfaces of the acetabula, the ischia, and the obturator foramina. They are about four inches in height, and converge slightly from above downward. Each lateral wall is traversed obliquely from the superior posterior angle of the obturator foramen to the spine of the ischium, by a slightly raised line or ridge, which marks off two inclined surfaces, one superior and posterior, the other inferior and anterior (Fig. 95, $_{10, 11}$). They are better marked in the female, and important on account of their influence upon the movements of the head of the child in parturition.

THE FEMUR.

The Femur (Fig. 97), situated between the pelvis and the tibia, is the longest and largest bone of the skeleton. Its direction is not vertical, but oblique from above downward and inward, the obliquity being greater in the female than in the male on account of the greater breadth of the female pelvis.

The *Shaft* of the bone is curved, with the convexity presenting forward, slightly twisted upon its axis, and in shape irregularly prismatic. Like most of the other long bones, it is smaller, harder, and more brittle in its middle than anywhere else. At this point the body is nearly cylindrical, and, below, rather flattened from before backward; the prismatic form is well marked above. It is described as having anterior, external, and internal surfaces.

The *anterior surface* is convex, both in a vertical and transverse direction, smooth, and broader above and below than in the middle; it follows the twist of the bone, and inclines a little outward superiorly, and inward below. The *external surface* is somewhat broader than the anterior, smooth, and slightly excavated above, but convex below. The *internal surface* is smooth and almost flat, and presents nearly backward at its inferior part, where it is also broader than it is above.

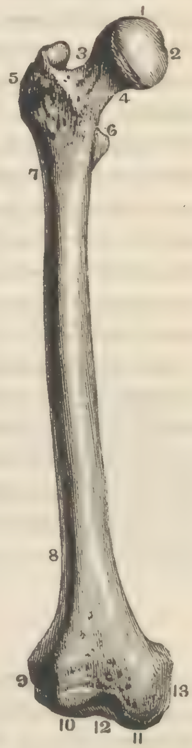
Of the three borders limiting these surfaces, the *internal* and *external borders* are smooth and rounded, but the *posterior* forms a prominent *rough line*, the *linea aspera*, extending nearly the whole length of the bone. Above and below, this line bifurcates, and, in the rest of its extent, is divided into an internal and an external lip, and an interspace for the attachment of muscles. The external branch of the superior bifurcation is very rough, and extends to the great trochanter; the internal passes below the small trochanter and joins the anterior intertrochanteric line. The two branches of the inferior bifurcation terminate, respectively, on the back part of the internal and external condyles; between them is a large, flat, triangular surface, which corresponds to the popliteal space or ham. In the lower part of the rough line, about the junction of the inferior third with the upper two-thirds of the bone, is the nutritious foramen, which penetrates from below upward and forward.

The *Upper Extremity* of the femur is somewhat flattened antero-posteriorly, and presents a large articulating process, and two non-articular eminences called trochanters.

The *articulating process* is placed upon the inner aspect of the bone, and directed obliquely upward, inward, and a little forward, its axis forming with the shaft below an obtuse angle, the degree of which varies in different individuals. In females and old persons generally, it is more nearly at a right angle. It is divisible into a head and neck.

The *head* (Fig. 97, $_1$), which constitutes the summit of the process, is smooth, convex, and more extensive above than below; it somewhat exceeds a hemisphere, and is marked a little below its middle by a rough depression for the attachment of the round ligament. In the recent state, it is covered with cartilage and received into the cotyloid cavity of the innominate bone.

Fig. 97.



Front view of right femur. 1, head of bone; 2, depression for round ligament; 3, 4, neck; 5, great trochanter; 6, small trochanter; 7, 8, shaft; 9, external condyle; 10, 11, articular faces for tibia; 12, trochlea for patella; 13, internal condyle.

The *neck* (Fig. 97, $_{3,4}$) is cylindrical, but flattened from before backward, so that a vertical section represents an oval, broader above than below, whose vertical axis exceeds the transverse by at least one-third. Posteriorly and inferiorly, the neck is much longer than it is anteriorly and superiorly; its line of union with the shaft is marked, in front, by a rough line passing between the trochanters, and called therefore the *anterior intertrochanteric line;* and, behind, by a projecting ridge, named the *posterior intertrochanteric line.*

The *great trochanter* (Fig. 97, $_5$) is placed externally to the neck, upon a little lower level than the head and in a line with the shaft of the bone. It is large, quadrangular, vertically prominent, subcutaneous, and rough for the attachment of muscles. Its external surface is irregularly convex, and covered by the great gluteal muscle, but may always be readily felt through the skin. Upon its inner face is a depression named the *trochanteric pit,* into which the tendon of one of the rotator muscles is inserted. The relations of the process to the crest of the ilium and spinous process of the pubis should be particularly observed as furnishing important aid in the diagnosis of injuries of the hip joint.

The *small trochanter* (Fig. 97, $_6$) is situated below and a little behind the lower border of the neck. Its posterior border is rough for the insertion of the common tendon of the psoas and iliac muscles, while the anterior is smooth for the gliding of the tendon, a mucous bursa intervening.

The *Lower Extremity* of the femur is very large, more particularly in a transverse direction, and is shaped somewhat like the clinched fist. Its inferior surface is divided behind by a broad deep notch into two smooth, convex, articular eminences, called *condyles* (Fig. 97, $_{9,\ 13}$), of which the

external is the larger and more nearly upon a line with the shaft of the bone, and the internal longer, narrower, and inclined a little inward. When the bone is held perpendicularly, the internal will be seen to project a little below the other; but, in its natural oblique position, both condyles rest upon a horizontal plane surface. In front of the notch the condyles unite to form a smooth, pulleylike surface, which extends a considerable distance upon the anterior aspect of the bone, for articulation with the patella. The external margin of this trochlear surface is much more prominent than the internal to obviate the natural tendency of the patella to dislocation in this direction. The lateral surfaces of the condyles are rough, perforated by numerous vascular foramina, and marked each by a small well-defined eminence for the attachment of the lateral ligaments of the knee joint. The one upon the external condyle is more prominent, and immediately behind it is a small fossa which gives origin to the tendon of the popliteus muscle.

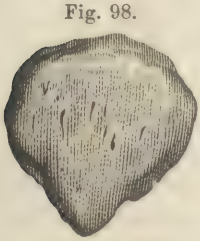
The femur articulates with the innominate, tibia, and patella. It is developed from five points of ossification, one each for the shaft, head, trochanters and lower extremity. The shaft is completely formed at birth, and the epiphysis for the condyles has begun to ossify. Ossific points make their appearance subsequently in the head, and great and small trochanter, which, however, are not consolidated with the shaft before the eighteenth or twentieth year.

THE PATELLA.

The Patella or Kneepan (Fig. 98) belongs to the class of sesamoid bones, of which it is the largest in the body. It is situated in front of the knee joint, is irregularly oval in shape, flattened from before backward, and presents two surfaces and a circumference.

The *anterior surface* is convex, marked by numerous small vertical ridges and furrows indicating the direction of the osseous fibres, and perforated by numerous nutritious foramina, which for the most part penetrate from below upward. In the recent state, this surface is covered by an expansion of the tendon of the extensor muscles of the leg, whose fibres are closely attached to the grooves and ridges, and continuous with the ligament of the patella below. The *posterior* or *articular surface* is divided by an oblique ridge into two lateral concave parts, of which the external is the larger; they correspond to the anterior surface of the condyles of the femur. The *superior* and *lateral borders* are thick and rounded, especially the former; the inferior is prolonged downward into a rounded angular process, whose posterior aspect is

Fig. 98.



Front view of the patella.

rough, for the attachment of the ligament that connects the bone to the tibia.

The patella consists almost entirely of close spongy tissue, a very thin layer of compact substance covering its exterior. A vertical section exhibits a well-marked fibrous arrangement of its component parts in a vertical direction, which accounts for the more frequent fracture of this bone longitudinally.

The patella is developed from a single ossific point which makes its appearance in the common tendon of the extensor muscles of the leg about two and a half years after birth.

THE TIBIA.

The Tibia (Figs. 99 and 100) is situated upon the inner side of the fibula. Unlike the femur it is vertical, and consequently parallel with its fellow of the opposite limb. The long, narrow interosseous space which separates the tibia and fibula is closed in the recent state by a strong fibrous membrane which is deficient only at the upper angle.

Fig. 99.

Tibia and fibula of left leg. 1, shaft of tibia; 2, 3, condyles; 4, spinous process; 5, tuberosity; 6, crest or shin; 7, lower extremity of bone; 8, internal malleolus; 9, shaft of fibula; 10, its head; 11, external malleolus.

The *Shaft* of the bone is remarkable for its uniform diminution in size from above downward to within about three inches of the inferior extremity. It is triangular prismatic in shape, especially above, and slightly twisted upon its axis.

The *internal surface* inclines a little forward, is broad above, where it is covered by the expansion of the tendons of the internal hamstring muscles, but gradually narrows toward the lower part, and is subcutaneous throughout nearly the whole of its extent.

The *external surface*, narrower than the internal, is excavated above for the origin of the anterior tibial muscle, but in the lower two-thirds of its extent is convex, and turned somewhat forward.

The *posterior surface* is broad above and narrow below, and traversed, at its upper part, by a raised line which runs from the external tuberosity downward and inward, marking off a triangular surface above, which is occupied by the popliteus muscle; immediately below this is the very large nutritious foramen of the bone. With these exceptions this surface is smooth and almost plane.

The three *borders* separating the three surfaces are all well marked.

The *anterior*, called the *crest* of the tibia, is subcutaneous; it commences superiorly in a large rough eminence called the *anterior tuberosity* of the tibia, descends a little outwardly, becomes very prominent in the middle third of the bone, and then, making a second curve with the convexity presenting inward, gradually subsides. The *internal border*, hardly observable above, becomes more prominent below; the *external*, sharp and rough throughout its whole extent, gives attachment to the interosseous membrane.

The *Upper Extremity* or *Head* of the tibia is thick and expanded, and presents a large transversely oval tabular surface for articulation with the femur. Traversing this surface from behind forward to within a short distance of the anterior edge, is a short but thick process or spine, which is bounded in front and behind by two rough depressions for the attachment of the crucial ligaments of the joint. By this spine and its two terminal depressions, the surface is divided into two shallow lateral excavations for articulation with the condyles of the femur. The internal is the smaller and oval from before backward; and the external is larger, less concave, and nearly circular.

The circumference of the articular surface is quite projecting posteriorly, and is here marked by a deep notch that divides the extremity into two lateral *tuberosities*, which support the articular fossæ, but do not correspond to them in size, the *internal* being the larger; the *external*, more prominent behind, presents below a small circular facet for the head of the fibula. The *anterior tuberosity* has been already mentioned; it is situated upon the anterior aspect of the bone about an inch below the articular surface, from whose anterior margin it is separated by a smooth triangular space perforated by several vascular foramina.

The *Inferior Extremity* of the tibia is thick, transversely elongated, and presents below a quadrilateral articular surface which is concave, but traversed from before backward by a rounded elevation, corresponding to the shallow groove upon the astragalus. The *anterior* and *posterior* margins are rounded and longer than the two lateral, and nearly parallel with each other. The *internal* is prolonged downward in a thick, transversely flattened, quadrangular pyramidal process, called the *internal malleolus*. The *external* presents a triangular, smooth, concave facet for articulation with the fibula, and is surrounded by numerous asperities for the attachment of ligaments.

The internal surface of the tibial malleolus is convex and subcutaneous, and the external concave and smooth for articulation with the astragalus. Its anterior border is rough and uneven; and the posterior, larger than the anterior, exhibits a large but shallow vertical groove for the lodgment of two of the flexor tendons of the foot. The summit is cut obliquely from behind forward and downward, and is rough for the attachment of the internal lateral ligament of the ankle joint.

The transverse axis of the two extremities of the tibia, owing to the torsion of the bone, are not parallel, and hence the internal malleolus is upon a plane anterior to the internal tuberosity.

The tibia articulates with the femur and astragalus, and indirectly with the patella. It is developed from three points, one for the shaft and one for each of the extremities; the former makes its appearance about the thirty-fifth or fortieth day, the latter two during the first and second years.

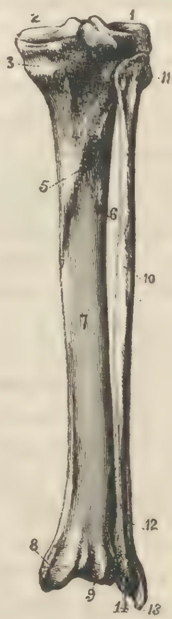
THE FIBULA.

The Fibula (Perone) (Figs. 99 and 100) is as long as the tibia, upon the outer side of which it is placed, but much smaller.

The *Shaft* is curved a little outward, remarkably twisted, triangular prismatic, but very irregular, and presents three narrow winding surfaces, and as many separating borders.

The *external surface* looks somewhat forward above, where it is also slightly excavated, but is turned nearly backward below, corresponding to the direction of the two peroneal muscles that are situated upon it. The *internal* inclines a little backward above, but becomes anterior below, and is divided by a longitudinal crest or ridge for the attachment of the interosseous membrane, into an anterior and posterior division, of which the posterior is broader and excavated. The *posterior*, turned slightly outward above, becomes internal below, where it terminates in a slightly convex rough surface which is in contact with the tibia.

Fig. 100.



Tibia and fibula of right leg, posterior view. 1, 2, articular surfaces for condyles of femur separated by spinous process; 3, inner condyle of tibia; 4, surface occupied by popliteal muscle defined by oblique line 5; 6, nutritious foramina; 7, surface covered by flexors of toes; 8, internal malleolus; 9, grooves for tendons; 10, shaft of fibula; 11, its head; 12, subcutaneous surface at lower part of bone; 13, external malleolus; 14, groove for tendons.

The three *borders* are well marked, and follow the winding course of the surfaces. The *anterior*, which becomes external in its course downward, bifurcates at the inferior extremity, inclosing a narrow triangular surface, that may be readily felt beneath the skin; the *external* and *internal* present nothing of special interest.

The *Superior Extremity* or *Head* of the fibula is convex and rough upon its external surface, but smooth internally where it articulates with the tibia; posteriorly, it presents a small prominence called the *styloid process*, to which the external lateral ligament of the knee joint and the tendon of the biceps muscle are attached.

The *Inferior Extremity* is oblong, flattened from side to side, thicker behind than before, and descends a considerable distance below the articular surface of the tibia, forming the *external malleolus* of the ankle joint. The external surface of the malleolus is convex and subcutaneous; the internal presents a smooth, slightly concave triangular facet for contact with the astragalus, and behind this a rough depression for the attachment of the transverse ligament of the joint. The anterior edge is thin and uneven, the posterior thick and superficially grooved for the tendons of the peroneal muscles. The *summit* gives attachment to the external lateral ligament of the ankle joint.

The fibula articulates with the tibia and astragalus. It is developed from three ossific points, of which the one for the shaft appears about the forty-fifth day.

THE TARSUS.

The Tarsus forms the posterior half of the foot, and consists of seven separate bones, the astragalus, calcaneum, cuboid, scaphoid, and the three cuneiform bones.

The **Astragalus** (Fig. 101, $_{1,2}$) is situated at the upper middle part of the tarsus, immediately below the tibia and above the calcaneum or heel bone. It is very irregularly cuboidal, and is the second bone of the foot in size. The *superior surface* presents a large smooth eminence for articulation with the tibia; it is convex antero-posteriorly, and concave transversely, and has abrupt lateral margins, which are also smooth and articular for contact with the internal and external malleoli. In front of this eminence is a rough surface for the attachment of ligaments. The *inferior surface* is divided into two parts by a deep groove directed obliquely from within outward and forward, and intended for the insertion of a ligament. In front of this groove is a small flat facet, and behind it a larger one, oval in shape, and concave for articulation with the calcaneum. The *anterior surface* joins the scaphoid, is convex, smooth, and transversely oval; it is sometimes called the *head* of the astragalus, and behind it the bone is somewhat constricted, so as to form a kind of neck. The *posterior surface* is narrow and almost entirely occupied by an oblique groove, which lodges the tendon of the flexor muscle of the great toe. The *two lateral surfaces*, below the base of the superior articular eminence, are rough, especially the internal, which presents a depression for the attachment of the internal lateral ligament of the ankle joint.

The astragalus articulates with the tibia and fibula, the calcaneum, and scaphoid bone.

The **Calcaneum** or heel bone (*os calcis*) (Fig. 101, $_{3}$) is situated beneath the astragalus, beyond which it projects posteriorly to form the promi-

nence of the heel. It is the largest bone of the tarsus, and, like the preceding, is irregularly cuboidal, but considerably elongated from before backward. It has four surfaces and two extremities.

The *superior surface* presents in front a rough depression for ligamentous attachment, and internal to this is a flat oblong facet for articulation with the astragalus. Behind the depression is another articular facet, larger than the preceding, convex, and inclined forward and inward, to join the larger facet of the astragalus, which looks in an opposite direction. Posteriorly, this surface is concave from before backward, and convex transversely.

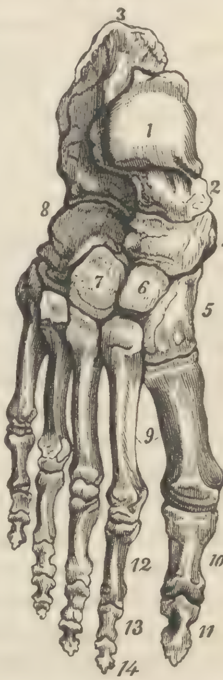
The *inferior surface* is much narrower than the superior, and presents posteriorly an *internal* and an *external tuberosity* for the origin of the short muscles of the toes; the internal of the two is much the larger. In front of the tuberosities the bone is somewhat excavated, and in front of the excavation it is rough and tuberculated.

The *external surface* is larger behind than before, and grooved anteriorly and in the middle for the passage of tendons. The *internal surface*, large and concave, lodges the tendons of the flexor muscles, the vessels and nerves, which go to the plantar surface of the foot. At its superior part is a special groove for the flexor tendon of the great toe.

The *anterior extremity* is quadrangular, smooth, concave vertically and convex transversely for articulation with the cuboid. The *posterior extremity* is convex, rough below for the insertion of Achilles' tendon and smooth above where the tendon glides over the bone. A little in advance of this extremity the bone is somewhat constricted, and may be fractured at this point.

The calcaneum articulates with the astragalus and cuboid.

Fig. 101.



Dorsal view of bones of foot. 1, trochlear surface of astragalus for articulation with tibia; 2, head of astragalus; 3, calcaneum or heel bone; 4, navicular or scaphoid bone; 5, 6, 7, internal, middle, and external cuneiform bones; 8, cuboid bone; 9, metatarsus; 10, first phalanx of great toe; 11, second phalanx of same; 12, first phalanges of four other toes; 13, second phalanges; 14, third phalanges.

The **Scaphoid** (Fig. 101, 4) is situated near the middle of the inner margin of the tarsus. It is transversely oval or elliptical, and flattened from before backward. Its *posterior surface* is smooth and concave for articulation with the head of the astragalus; the *anterior*, also smooth and convex, is divided into three triangular facets for articulation with

the three cuneiform bones. Of these three divisions, two, the external and middle, are broader above than below; whereas the internal and largest is broader below than above. The circumference of the bone is thick, convex, and rough, and frequently marked externally by a small facet for contact with the cuboid. A small *tuberosity*, situated below and internally, gives insertion to the posterior tibial muscle.

The scaphoid articulates with the astragalus and the three cuneiform bones.

The **Cuboid** (Fig. 101, $_8$) is situated in front of the calcaneum and forms part of the outer border of the foot. It articulates by its *posterior surface* with the anterior extremity of the calcaneum; by its *internal* with the external cuneiform; and by its *anterior* with the fourth and fifth metatarsal bones. Its *lower surface* is traversed from without inward and forward by a deep groove which lodges the tendon of the long peroneal muscle.

The **Cuneiform Bones** (Fig. 101, $_{5,\,6,\,7}$), three in number, are situated between the scaphoid and the first three metatarsal bones, and, as their name indicates, are wedge-shaped.

The *Internal Cuneiform* is the largest, and has its base downward. Its *anterior* and *posterior surfaces* are triangular and smooth for articulation, the former with the first metatarsal bone, and the latter with the scaphoid.

The *Middle Cuneiform* is the smallest, and placed between the other two with its base upward. Its *posterior surface* articulates with the scaphoid and its *anterior* with the second metatarsal bone. In consequence of its small size it does not extend as far forward as the two bones between which it is placed, but forms with them a mortiselike notch in which the extremity of the metatarsal bone is received.

The *External Cuneiform* is larger than the preceding, and like it has its base turned upward. It articulates with the scaphoid *behind*, the cuboid *externally*, the middle cuneiform *internally*, and the third metatarsal bone *in front*.

Development of the Tarsal Bones.—Ossification of the tarsal bones commences much earlier than in the carpal bones. The latter are entirely cartilaginous at birth, but the calcaneum, astragalus, and cuboid of the former are each somewhat advanced. Each of the bones is developed from a single point, except the calcaneum, upon whose posterior extremity an epiphysis is developed about the tenth year, which joins the rest of the bone a short time after puberty. The order of appearance of the ossific points is as follows: 1, the calcaneum about the sixth month of fœtal life; 2, the astragalus about the seventh; 3, the cuboid during the ninth; 4, the external cuneiform in the course of the first year after birth;

5, the internal or first cuneiform in the third year; 6, the middle cuneiform in the beginning of the fourth year; and lastly the scaphoid toward the latter part of the fourth year. The completion of the whole does not occur until the epiphysis of the calcaneum is united to the body of the bone.

THE METATARSUS.

The Metatarsus (Fig. 101, $_9$), the second division of the foot, is composed of five small bony columns, placed side by side, and distinguished from each other numerically, counting from within.

Taken as a whole, the metatarsus is a quadrilateral grating, convex above and concave below. Its posterior edge is not straight; but irregular and articulated with the anterior extremity of the tarsus, formed by the three cuneiform and scaphoid bones. The anterior edge is curved, the convexity presenting forward, and is formed by five rounded heads for articulation with the first phalanges of the toes. The internal and external edges, of which the former is the thicker, correspond to the lateral margins of the foot.

The metatarsal bones belong to the class of long bones, and consist, each, therefore, of a body and two extremities. The *body* is triangular prismatic, and slightly curved with the convexity presenting upward, and separated from the adjoining bone by an interspace for the lodgment of the interosseous muscles. The *posterior* or *tarsal extremity* is comparatively large and somewhat wedge-shaped, the broad edge or base looking upward. The tarsal surface is smooth, plane, triangular, and articulates with the tarsus; the two lateral surfaces present articular facets for union with the contiguous bones of the same group. The *anterior* or *digital extremity* is expanded into a rounded head with flattened sides, upon which may be observed rough depressions and tubercular eminences. The smooth convex surface of the head is oblong from above downward, and of greater extent below than above, corresponding thus to the flexion of the toes, which is much greater than their extension.

The *first metatarsal bone* is the thickest and shortest of the group. Its tarsal extremity is elongated from above downward, and has no lateral articular facet, but presents a concave semilunar surface for articulation with the first cuneiform bone. Its digital extremity is large and marked below by two vertical grooves for the play of the two sesamoid bones.

The *second* is the longest of the group. Its tarsal extremity is received between the first and third cuneiform bones, resting upon the second; it articulates also with the third metatarsal bone.

The *third* and *fourth* are very nearly alike, but the former is a little the longer. When in their natural position, however, the tarsal extremity

of the latter projects behind the former to reach the metatarsal surface of the cuboid, which is upon a plane posterior to that of the third cuneiform.

The *fifth* is the shortest of the group except the first. Its tarsal extremity is large, has but one lateral articular facet, and presents upon its outer side a large triangular pyramidal process which projects obliquely backward, and a little outward for the insertion of the small peroneal muscle; being readily felt beneath the skin, it forms an important guide to the amputation of the foot at the tarso-metatarsal articulation.

Development of the Metatarsal Bones.—Like the metacarpal, the metatarsal bones are each developed from one principal and one epiphysary point, the latter occurring upon the tarsal extremity of the first, and upon the phalangeal extremities of all the others. The central point appears in the bodies of the bones between the seventh and eighth week of fœtal life; the epiphysary point appears successively in the several bones, beginning with the first, in which the process commences during the third year. The fifth is not entirely completed before the sixth or seventh year.

THE TOES.

The Toes (Fig. 101, $_{10-14}$) contain the same number of phalanges as the fingers, and as their general characteristics are so nearly alike, a separate description of the former is not necessary. The principal mark of difference lies in the greater length of the bones of the fingers, the second phalanges of the toes being so short as to exclude them from the class of long bones. This is not true, however, of the two phalanges of the great toe, which are longer and much thicker than those of its analogue, the thumb.

Development of the Toes.—The phalanges of the toes are developed from two ossific points, one for the shaft and anterior extremity, and one for the posterior extremity. The former makes its appearance some time after that of the corresponding metatarsal bone; the latter about the same time with the epiphysis. Ossification of the two phalanges of the great toe, however, takes place earlier than the others.

THE HYOID BONE.

The Hyoid Bone does not form a part of the skeleton proper, but is connected with the tongue and larynx, between which it is situated in the upper front part of the neck. It is shaped somewhat like the Greek letter υ, from which it derives its name, and consists of a body and two processes on each side, called horns.

The *body* or central portion is flattened, about half an inch broad, and terminates laterally and behind in the horns. It has two oblique surfaces and two borders.

The *superior surface* looks outward as well as upward, is convex transversely, and marked in the middle line by a slight vertical ridge, which separates two shallow depressions for the attachment of the stylo-hyoid, sterno-hyoid, and digastric muscles.

Fig. 102.

Hyoid bone seen from before. 1, antero-superior or convex side of body; 2, great horn of left side; 3, lesser horn of same side. The horns were ossified to body of bone in specimen from which this figure was drawn.

The *inferior surface* looks downward and inward, is concave and smooth, and separated from the anterior surface of the thyro-hyoid membrane by a mucous bursa.

The *anterior* and *posterior borders* are horizontal but irregular. The former gives attachment to muscles, and the latter to the thyro-hyoid membrane and root of the tongue.

The *posterior* or *greater horns* (cornua) are the extremities of the bone. They are in a line with the body, and terminate in rounded points for the attachment of the thyro-hyoid ligaments.

The *anterior* or *smaller horns* (cornicula) are two little conical processes which project upward and outward from the superior border of the bone where the body joins the greater horns. They generally remain cartilaginous until advanced age, and give attachment to the stylo-hyoid ligaments.

The hyoid bone is developed from five points, one for the body and one for each of the processes. Those for the body and larger horns make their appearance just before birth.

THE SESAMOID BONES.

The Sesamoid Bones are osseous nodules of various sizes, developed in the tendons of some of the muscles of the extremities, where their office seems to be that of a fulcrum. As a general rule they are small, rarely, except in the case of the patella, exceeding the size of a grain of coffee, which they also usually resemble in shape. They are found principally in the flexor tendons, to which law the patella is an exception also, and are nearly always present in the tendinous origins of the gastrocnemius muscle behind the condyles of the femur, and in the flexor tendon of the great toe beneath the head of the corresponding metatarsal bone. In structure they resemble the short bones. They are not found in young subjects, but are developed in the substance of the tendons about the age of manhood, and often later.

ODONTOLOGY.

The Teeth have been considered by various anatomists as forming a part of the skeleton, as appendages to the dermoid tissue, and as parts of the digestive apparatus, but they are now generally recognized as constituting a special structure, the study of which is called Odontology. Although bearing some likeness to bone, they differ from this tissue in the following particulars: 1, they are destitute of periosteum; 2, they consist of an interior nervous pulp surrounded by a calcareous substance divisible into two distinct structures, called enamel and ivory, which contain no bloodvessels or nerves; 3, they are developed from the circumference toward the centre by successive depositions; 4, they are not nourished like bone; 5, by chemical analysis they are found to contain a much larger amount of earthy matter, and the enamel is entirely destitute of gelatin; 6, their physiological relations, including their duration, are widely different; 7, their diseases are unlike. Their dissimilarities to the dermoid tissue are not so numerous, but sufficient to distinguish them.

The teeth are divided, in reference to their duration, into *temporary* and *permanent.* The former precede the latter in the order of their development, and subserve, as their name implies, only a temporary purpose.

The number of temporary teeth is usually twenty, ten in each jaw; the permanent set are thirty-two, sixteen in each jaw. These numbers, however, are sometimes found to vary, the variation being either in excess or deficiency, but more frequently the latter.

In their natural position and relation, the permanent teeth form two parabolic curves called the dental arches, one of which is superior and the other inferior. The size of these arches, however, is not the same; the superior forms, as it were, the larger extremity of an oval, and the lower the smaller end. Each arch presents an anterior convex, and a posterior concave surface, a free border, and a base or attached border. The free borders of the two arches are thin and sharp at the middle, but thick and uneven laterally. They do not exactly correspond at all points, owing to the smaller size of the inferior, whose anterior or middle part rests a little behind the superior, when the mouth is closed; laterally and posteriorly,

however, they are directly opposed. This arrangement is connected with the different offices of the anterior and posterior divisions, the former being intended for tearing and cutting the food, and the latter for grinding it to a proper pulplike mass.

The teeth are distinguished by their differences in size and form into three classes, namely, the incisors, the canine, and the molars. The first class numbers four in each jaw, the second two, and the third ten. They have, however, certain characters in common. Thus, each tooth consists of two distinct parts, a *body* and a *root* or *fang*, the former being free, and projecting beyond the gum, the latter implanted in the alveolus or socket; the slightly constricted part between the two, to which the gum is attached, is called the *neck*. A second general character is the nearly vertical direction of the axis of each, which is peculiar to the human race. Lastly, the bodies of all the teeth, with the exception of the canine, are of nearly equal length.

Fig. 103.

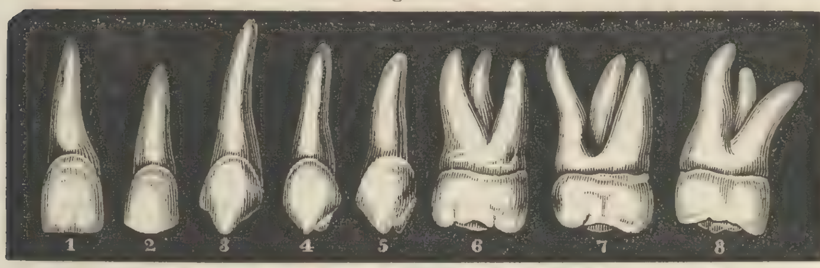


Fig. 104.

Fig. 103, permanent teeth of upper jaw; Fig. 104, of lower jaw. 1, 2, incisors; 3, canine; 4, 5, bicuspids or small molars; 6, 7, 8, large molars or grinders.

The **Incisor Teeth** (Figs. 103 and 104, $_{1,\,2}$) occupy the anterior part of the dental arches, and are larger in the upper than in the lower jaw. They are distinguished into middle and lateral incisors. The middle incisors of the upper jaw are much larger than the lateral, but the inferior lateral are larger than the middle.

The bodies of the incisor teeth are wedge-shaped, and have four surfaces and a free edge. The anterior surface is convex and smooth, and

somewhat broader near the edge than the root. The posterior surface, also broadest near the edge, is concave, and smooth, and often grooved in a vertical direction. The lateral surfaces, broadest near the root, are plane and less polished than the anterior. The free edge of the superior incisors is sharp and beveled at the expense of the posterior surface, but that of the inferior is thicker, and cut, as it were, from the anterior surface.

The roots of the incisor teeth are single, conoidal, flattened from side to side, and perforated at the end by a very small opening which communicates with the cavity of the tooth. The neck of each incisor is marked by an anterior and a posterior curved line, whose concavity is directed toward the free edge.

The **Canine Teeth** (Figs. 103 and 104, $_3$), two in each jaw, are situated between the incisors and molars. They are the longest of all the teeth, and those of the upper jaw are somewhat larger than the inferior. Their bodies are broad, convex, and smooth in front, somewhat contracted and concave behind, narrow and convex on the sides, and terminated by an obtuse point which projects beyond the level of the others. Their roots are single, larger and longer than those of the incisors, conoidal in shape, grooved upon their lateral surfaces, and perforated at the summit.

The roots of the superior canines are on a line with the ascending processes of the superior maxillary bones, into the base of which they often extend. The neck, like that of the incisors, is marked by two curved lines.

The **Molars** are divided into two classes, the small and large; the former, two in number on each side, are situated directly behind the canine; the latter, three upon each side, occupy the posterior parts of the dental arches. They are also called *bicuspids* and *multicuspids*, which names are derived from the number of points upon their cutting edge or crown.

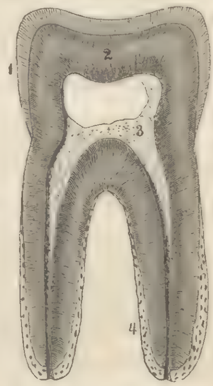
The body of the *Small Molars* (bicuspids) (Figs. 103 and 104, $_{4,5}$) is irregularly cylindrical, convex, and smooth upon its external and internal surfaces, broader, nearly plane, and less polished upon its anterior and posterior surfaces. The free edge or crown, much more extensive than that of the incisors and canines, is elongated from within outward, and marked by two little tubercles or prominences, of which the external is the larger and more elevated. The root, generally single but sometimes bifid or double, is conoidal, flattened from before backward, and marked by a vertical groove upon its anterior and posterior surfaces. The neck is nearly circular and horizontal. The small molars have been likened to two canine teeth united.

The body of the *Large Molars* (multicuspids) (Figs. 103 and 104, $_{6,7,8}$), much larger than the preceding, is cuboidal, convex upon its external

and internal, and plane upon its anterior and posterior surfaces. The grinding surface of the tooth is marked by four prominences or tubercles separated by a crucial furrow. In advanced age, this surface is perfectly plane and smooth, the points having become gradually worn away. The roots or fangs of the large molars vary in number from two to five; as a general rule, however, the superior teeth have three, and the inferior two. These fangs are either divergent, or parallel for a little way and convergent at the extremities, and sometimes they are hooklike; the summit of each is perforated for the dental nerves.

The last molar tooth is called, from the lateness of its appearance, the *wisdom tooth* (dens sapientiæ). It is smaller than the others, often has but one fang, and of all the teeth, as a general rule, most apt to decay. It is also distinguished by its having but three tubercles upon its crown.

Fig. 105.



Vertical section of a molar tooth, moderately magnified. 1, enamel, lines of which indicate arrangement of its columns; 2, dentine, lines indicating course of its tubules; 3, thin lamina of dentine forming wall of pulp cavity, dots indicating orifices of dentinal tubules; 4, cement.

Structure of the Teeth (Fig. 105).—Every tooth has an internal cavity, which varies in size at different periods of life, being greatest in teeth not fully developed, and gradually diminishing as age advances. This cavity is hollowed out of the body of the tooth from whence it is prolonged into the fangs, upon the summits of which it terminates in an orifice for the admission of the dental bloodvessels and nerves. It follows from this that the cavity is single in teeth which have but one root, but in those that have several roots it presents as many prolongations, all, however, uniting in the main cavity, which is situated in the body of the organ. In the fresh state, this cavity is occupied by a white, gelatinous-looking substance called the *dental pulp* or *papilla*, which consists of a membranous expansion of the dental nerve together with numerous bloodvessels.

The hard part of the tooth consists of three distinct substances, namely, the dentine, the enamel, and the cement.

The *Dentine* or *Ivory* (Fig. 105) constitutes by far the largest part of the tooth, the two other substances forming only an external covering or crust. To the naked eye, it seems to differ but little from the compact tissue of ordinary bone; it is, however, much harder, owing to its larger amount of earthy matter, and is entirely destitute of bloodvessels and nerves. Viewed with the microscope, it is found to be penetrated by an infinite number of minute canals or tubules (Fig. 106), which commence upon the walls of the internal cavity by open mouths, and pass in an undu-

lating and nearly parallel direction toward the under surface of the enamel and cement, where they terminate. In their course these canals often bifurcate, and this is more particularly the case in those which run to the under surface of the enamel, the division taking place immediately before they reach this structure. The small size of these canals precludes the admission of the red corpuscles of the blood, but they are found to contain a transparent watery fluid, which in all probability is derived from the bloodvessels of the pulp, and is supposed by physiologists to furnish nutriment to the intertubular substance.

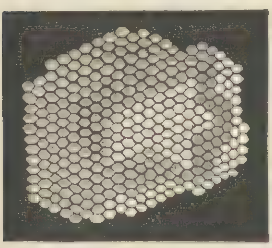
Fig. 106.

1, tubules of dentine; 2, enamel.

Dentine consists of twenty-eight parts of animal substance, and seventy-two of earthy constituents, of which latter phosphate of lime comprises sixty-two parts.

The *Enamel* (Figs. 105, 106, and 107), the hardest part of the tooth, and also the hardest organic substance known except the diamond, constitutes the external part of the body of the tooth, and forms a protecting capsule to the inclosed dentine. It is generally thickest upon the grinding surface, and becomes gradually thinner toward the neck, where it ends abruptly. Examined in mass, it is translucent, of a bluish white or milky color, and extremely brittle. The microscope shows it to consist of slightly undulating but nearly parallel solid columns of a hexagonal form, applied by their internal extremities to the outer surface of the dentine, from which they radiate in the manner represented in Fig. 105. The columns are about $\frac{1}{160}$ of a line in diameter, and transversely striated. Enamel has no vessels of any kind. It consists of only four or five parts of animal matter to ninety-five of earthy salts; the latter mostly phosphate of lime.

Fig. 107.



Transverse section of enamel, representing hexagonal form and arrangement of enamel columns of fibres. (After Retzius.)

The *Cement* (crusta petrosa) is a thin layer of ordinary bone (Fig. 105) which covers the outer surface of the roots of the teeth, and terminates at the margin of the enamel; it is thickest near the extremities of the roots.

The teeth are implanted in the alveolar cavities, which are moulded

accurately upon the roots, a delicate layer of periosteum intervening. This articulation would not, however, be entirely secure without the aid of the gum, which is closely attached around the neck of the tooth, and assists materially in holding it in its position.

The teeth are supplied with blood by branches from the internal maxillary artery. Their nerves are derived from the second and third divisions of the trifacial.

ARTHROLOGY.

Arthrology has for its object the study of the connections or articulations of the several pieces of the skeleton, one with another. The manner in which these connections are made, and the means employed, vary in different parts of the body, according to the offices which the several parts have to perform. Thus, in the cranium, a close and immovable union of the bones is required for the protection of the inclosed brain; in the spinal column, solidity and a certain degree of mobility or elasticity combine to give great strength, and at the same time allow the different movements of the trunk of the body; lastly, in the extremities, solidity gives place to a great degree of mobility in accordance with the functions of the limbs. It will be seen then that there are at least three varieties of articulation, the characteristics of which are respectively: 1, immobility; 2, solidity, with a slight degree of yielding; and 3, great mobility. The first of these varieties is called synarthrosis; the second, amphiarthrosis; the third, diarthrosis.

Synarthrosis.—All the bones of the head, except the lower jaw, are joined together by the synarthrodial or immovable articulation, but the exact manner in which the surfaces are applied is not the same between all the bones; the subdivisions that have been established by anatomists are the *indented suture*, in which the surfaces are provided with tooth-like processes; *squamous suture*, in which the edges overlap like scales; *harmonic suture*, in which there is a simple contiguity of two rough surfaces; and lastly, *schindylesis*, in which the edge of one bone is received into a groove of another.

The means of union in synarthrodial articulations consist of only a thin layer of bone-cartilage which, although easily demonstrated in the young subject, generally becomes ossified in advanced age.

Amphiarthrosis or Symphysis.—The bones united together by this mixed sort of articulation are the bodies of the vertebræ, the ilium and sacrum, and the two pubic bones. The means of union consist of a plate of fibro-cartilage, situated between the contiguous surfaces, and of surrounding ligaments.

Diarthrosis.—The diarthrodial or movable articulations are very numerous; they present great differences in the form of the articulating surfaces, and in the kind and extent of their motions, and have, therefore, been variously classified. The most important subdivisions are the following: 1. *Enarthrosis*, or the ball-and-socket joint, in which a rounded head is received into a corresponding cavity, as in the shoulder and hip joint; in articulations of this kind, all the different kinds of motion are allowed, such as flexion, extension, abduction, adduction, circumduction, and rotation. 2. *Arthrosis*, in which the surfaces are plane, and the motion limited and of a gliding nature, as between the articular processes of the vertebræ, the ribs and transverse processes of the vertebræ, and the carpal and tarsal bones. 3. *Trochlear articulations* or *Ginglymus;* this species includes all those joints in which one of the opposed surfaces is shaped like a pulley, such as the elbow joint, the knee joint, the joints of the phalanges, etc. in some of which the motions are only in opposite directions, but in others a slight degree of abduction, adduction, and circumduction are allowed.

In the diarthrodial articulations, the opposed surfaces are accurately adapted to each other, incrusted with cartilage, and invested with a synovial membrane. In some a separate plate of fibro-cartilage is placed between the articulating surfaces. The means of union consist of peripheral ligaments, tendons, and muscles, and in some instances intrinsic or interarticular ligaments.*

ARTICULATIONS OF THE SPINAL COLUMN.

Articulations of the Vertebræ with Each Other.—The articulations of the vertebræ with each other are of two kinds, amphiarthrodial and diarthrodial; the former occur between the bodies of the bones, and the latter between the oblique or articular processes. In order to obtain a good view of the whole, the column should be entirely cleared of muscles and other appendages, the two pedicles of each vertebra sawed through, and the spinal cord and membranes removed.

The *Bodies* of the vertebræ are joined together by an anterior and a posterior common ligament, and an intervertebral fibro-cartilage.

The *Anterior Common Ligament* is a band of white, pearly-looking fibres attached to the front of the bodies of the vertebræ and intervertebral fibro-cartilages, and extending from the axis to the sacrum. It is broader below than above, and thickest in the dorsal region, and consists of several layers of fibres, the most superficial of which are stretched

* For an account of the structure of these several tissues, see General Anatomy, arts. Cartilage, etc.

from one vertebra to the fourth or fifth below; but the deep seated extend only between the contiguous bones. It fills up the transverse grooves on the anterior surfaces of the bodies of the vertebræ, but upon each side of the median line the fibres are scattered and stretch across these grooves, forming canals for the passage of bloodvessels. This ligament is more adherent to the intervertebral substance and margins of the vertebræ than to the middle of the bodies of the latter.

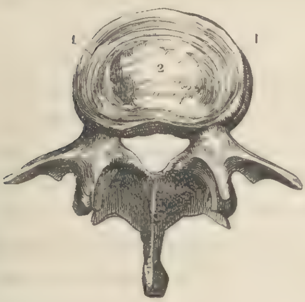
The *Posterior Common Ligament* is situated within the spinal canal upon the posterior aspect of the bodies of the vertebræ, and reaches from the occiput to the sacrum. It is not of uniform breadth at all points, but broader opposite each plate of intervertebral substance, so that its borders have a scalloped appearance. It is closely attached to the intervertebral substance, but is separated from the middle of the bodies of the vertebræ for the exit of the veins of the latter. Its posterior surface is separated from the membranes of the spinal cord by loose areolar tissue and fat.

The *Intervertebral Fibro-cartilage* consists of a series of plates or disks situated between the horizontal surfaces of the bodies of the vertebræ, to which they are intimately attached. The disks correspond exactly to the surfaces between which they are placed, and are, therefore, for the most part slightly convex upon both sides, transversely oval in the lumbar and cervical regions, and circular in the dorsal. Their thickness varies with the degree of motion in the part, and is greater, therefore, in the cervical and lumbar regions than in the dorsal. Again, they are not uniformly thick throughout their entire circumference, those of the cervical and lumbar region being thicker in front than behind, and those of the dorsal region thicker behind than in front. It is by this arrangement that the antero-posterior curves of the column are mainly produced. Taken together, they form at least one-fourth of the length of the spinal column from the skull to the sacrum.

The *structure* of the intervertebral substance may be exhibited by a vertical division of two contiguous vertebræ (Fig. 109), when it will be seen to consist of a series of concentric layers placed upon edge between the opposed bones, and inclosing at the centre a soft pulpy substance which is pure cartilage, of a whitish, glairy, jellylike appearance. The cut edges of the layers, as seen in a section of this kind, are not perfectly straight, but somewhat curved, the most external presenting a convexity outward, and the internal inward. Interposed between these concentric layers is a small quantity of the same glairy cartilage found at the centre, which gradually increases from without inward. The concentric layers are composed of fibres which pass obliquely between the two bones, those of one layer crossing the direction of the fibres of the adjacent layer. In a horizontal section of the intervertebral substance (Fig. 108), these layers look like concentric fibres, and were so considered by the older anato-

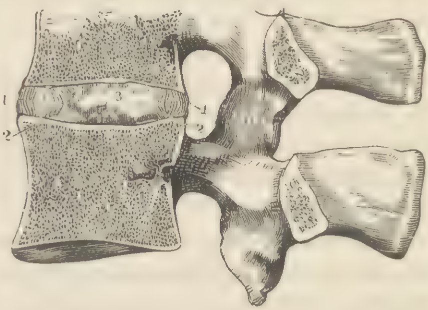
mists. The inclosed semifluid pulp is entirely devoid of fibres, very elastic, and seems to be in a state of constant compression, so that when a knife is plunged through the surrounding fibrous layers and withdrawn, the pulp often follows it and forms a kind of hernia.

Fig. 108.



Lumbar vertebra, with horizontal section of intervertebral substance above it. At circumference concentric arrangement of layers of latter is shown, and in middle pulpy substance is indicated.

Fig. 109.



Vertical section of two vertebræ and substance interposed between their bodies. Direction of layers of intervertebral substance is displayed. 1, layers curved outward; 2, those curved inward; 3, pulpy substance in middle.

The *Articular Processes* of the vertebræ form true diarthrodial joints, and are therefore covered with cartilage and invested with synovial membrane. They are bound together by numerous short peripheral fibres, which form an imperfect capsule, somewhat longer and looser in the cervical and lumbar regions than in the dorsal, corresponding to the greater mobility of the former.

Besides the ligaments immediately surrounding the two sets of articulations between the vertebræ, others connect the *Arches* or *Laminæ* and the *Transverse* and *Spinous Processes.*

The ligaments (*ligamenta subflava*) connecting the laminæ or arches are very short and broad, extending on each side from the root of the transverse to the root of the spinous process. They consist of yellow elastic tissue, whose fibres are attached above to the anterior aspect of the lower margin of the arch, and below to the posterior aspect of the superior margin.

The *Intertransverse Ligaments* are so blended with the tendons of the surrounding muscles of the back, that it is difficult, and oftentimes impossible, to demonstrate them as separate structures. They consist of very short white fibres, passing directly between the corresponding borders of the processes.

Two sets of ligaments are recognized as connecting the spinous processes, the *Supraspinous* and the *Interspinous Ligaments.* The former are quite distinct, and consist of small fasciculi of fibres attached to the

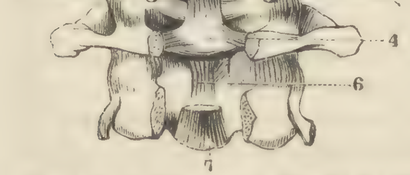
summit of each spinous process, and extending to the third or fourth bone below, thus forming a continuous cord from the seventh cervical vertebra to the sacrum. The interspinous ligaments are found only in the dorsal and lumbar regions; they consist of a few short narrow bundles of fibres, placed nearly vertically between the corresponding borders of the spinous processes, and extending from the root to near the point of each.

Articulations of the First and Second Vertebræ.—This articulation, called the *atlanto-axoid*, is a quadruple diarthrosis, and results from the contact of the articular processes of the two bones, and of the odontoid process of the axis with the anterior arch of the atlas and the transverse ligament.

The articulation of the articular processes does not differ from that between the corresponding parts of the other vertebræ, except in the shape and direction of the surfaces, which, as heretofore described, are circular and nearly horizontal. These surfaces are covered with cartilage, provided with synovial membranes, and bound together by surrounding ligamentous fibres, which form an imperfect loose capsule upon each side.

The articulation between the odontoid process and the atlas consists of a small, oblong, concave facet upon the posterior surface of the anterior arch of the latter, and a corresponding smooth convex surface upon the anterior aspect of the process; the two are covered with cartilage and provided with a loose synovial membrane.

Fig. 110.



In this drawing posterior arch of occiput and two upper vertebræ are removed. 1, basilar process; 2, anterior condyloid foramen; 3, jugular foramen; 4, transverse ligament of atlas; 5, its superior fasciculus; 6, its inferior fasciculus; 7, posterior vertebral ligament.

The ligaments which bind the two bones together are three in number: 1. The *Anterior Atlanto-axoid Ligament*, which is tolerably thick, broad, and strong, and extends from the lower edge of the anterior arch of the atlas to the base of the odontoid process, where it is continuous with the anterior common ligament of the spinal column. 2. The *Posterior Atlanto-axoid Ligament* is thin and membranous, and interposed between the posterior arch of the atlas and the laminæ of the axis. 3. The *Transverse Ligament* is stretched between the roots of the superior articular processes of the atlas, and forms with the anterior arch of this bone a kind of ring for the reception of the odontoid process; it is thick

and strong, flattened from before backward, and presents upon its anterior surface a small concave cartilaginous facet, for contact with the posterior surface of the odontoid process, which is similarly furnished, a synovial membrane intervening. A small fibrous band passes from the middle of this ligament, to the posterior edge of the basilar process of the occipital bone above, and to the body of the axis below, where it is continuous with the posterior common ligament (Fig. 110, 5, 6).

Articulations of the First and Second Vertebræ with the Occipital Bone.—The atlas is articulated with the occipital bone by the contact of the articulating processes of the former with the condyles of the latter, forming thus a double diarthrosis. The contiguous surfaces of these parts are covered with cartilage, furnished with synovial membrane, and surrounded by short ligamentous fibres, which form a sort of capsule for each joint. The ligaments are four in number: 1. The *Anterior Atlanto-occipital Ligament* extends between the posterior margin of the basilar process of the occipital bone and the anterior arch of the atlas; in the median line, the fibres are collected into a thick rounded cord, which is attached below to the tubercle of the anterior arch; upon each side of this the ligament is membraniform, but still quite thick and strong. 2. The *Posterior Atlanto-occipital Ligament* is very thin and delicate, and hardly deserves to be mentioned; it extends from the posterior edge of the great foramen of the occipital bone to the superior margin of the posterior arch of the atlas. 3. The two *Lateral Atlanto-occipital Ligaments*, one upon each side, are short, strong, and cordlike; they are attached above to the jugular process of the occipital bone, and below to the base of the transverse process of the atlas.

The occipital bone, although not in contact with the second vertebra, is attached to it by several strong ligaments. The *Occipito-axoid Ligament* is a continuation of the posterior common ligament of the spinal column from the posterior surface of the body of the axis to the anterior margin of the great foramen. It is broad, covers in the odontoid process behind, and is sometimes considered as consisting of three portions, a middle and two lateral. The *Odontoid Ligaments* are three in number, two lateral and one median. The *lateral*, *moderator* or *check ligaments*, as they are variously termed, extend between the sides of the extremity of the odontoid process and two rough depressions upon the inner side of the condyles of the occiput. They are thick and strong, and, by their almost horizontal direction, serve to check the rotatory motions of the head. The *middle odontoid ligament* consists of a few scattered fibres extending from the summit of the odontoid process to the anterior margin of the great foramen.

The Sacro-vertebral, Sacro-coccygeal, and Coccygeal Articulations.—The *Sacro-vertebral Articulation* does not differ from the inter-

vertebral generally, except in the greater thickness and wedge-shape of the fibro-cartilaginous disk, and in having an additional ligament, the sacro-vertebral, which is short and thick, and extends obliquely from the transverse process of the last lumbar vertebra to the lateral surface of the base of the sacrum, blending at its insertion with the sacro-iliac ligaments.

The *Ilio-lumbar Ligament* is a triangular flattened band of fibres, extending from the apex of the transverse process of the last lumbar vertebra to the posterior extremity of the iliac crest, thus serving to strengthen this articulation as well as that between the sacrum and ilium.

The *Sacro-coccygeal Articulation* occurs between the small, transversely oval, convex surface on the summit of the sacrum, and the corresponding concave surface on the base of the coccyx. It is generally amphiarthrodial, a small plate of fibro-cartilage connecting the two surfaces, but sometimes this disk is wanting, and its place supplied by ordinary articular cartilages and a synovial membrane, in which case the joint is, of course, diarthrodial. The proper ligaments are, an *anterior*, which consists of somewhat scattered parallel fibres extending between the anterior surfaces of the bones; and a *posterior*, attached to the posterior margin of the inferior termination of the sacral canal and the corresponding surface of the coccyx, the most superficial fibres reaching as far as the extreme point of the latter bone.

The *Coccygeal Articulations*, situated between the several pieces of the coccyx, are similar to the sacro-coccygeal, and require no separate description. The only thing remarkable about them is their tendency to become immovable, which is nearly always the case in advanced age.

ARTICULATIONS OF THE CRANIUM AND FACE.

All the bones of the cranium are joined together by synarthrodial articulations, which form what are commonly known as the sutures of the skull. This mode of union is particularly adapted to the cranium, as it is more necessary here, than in any other part of the skeleton, to have solidity without the least degree of motion.

The exact manner in which the edges of the bones are arranged is not the same in all parts of the cranium. Thus, in the vaulted portion, the opposed edges are nearly all serrated or denticulated, the slightest film of cartilage intervening; but at the base these indentations are much less marked, the solidity here depending, in a great measure, upon the greater breadth of the opposed surfaces, and their firm attachment to each other by fibro-cartilage.

For a description of the conformation and disposition of these articular surfaces, the student is referred to the account of the separate bones, and to that of the skull in general.

The union of the bones of the face with one another, except that between the lower jaw and temporal bone, is also synarthrodial, and here we have all the varieties which this species of articulation presents. Thus, in the union of the nasal and superior maxillary bones with the frontal, there exists a true *denticulated suture;* in that between the orbital plate of the ethmoid and the sphenoid, and between the palate bone and the pterygoid processes, simple juxtaposition or *harmonica;* in that between the vomer and the median ridge, on the floor of the nasal cavities, *schindylesis;* and in that between the vomer and sphenoid, *articulation by mutual reception.*

The means of union between these bones consists simply of a thin layer of cartilage. The configuration of the surfaces makes any extrinsic ligaments unnecessary.

Temporo-maxillary Articulation.—The articulation between the lower jaw and temporal bones is a double diarthrosis. The articular surfaces are the two condyles of the former bone, and the two glenoid cavities of the latter. The glenoid cavity, as already described, is transversely oval, and divided by the glenoid fissure into two parts, of which only the anterior is articular. The anterior root of the zygoma, which is convex from before backward and concave from within outward, bounds the cavity in front, and also enters into the articulation. The condyles are transversely oval with their long axes directed slightly backward, and are found in man, and in the ruminantia, always disproportionately small in comparison with the glenoid cavities.

As in all other diarthrodial articulations, the opposed surfaces are incrusted with cartilage, and invested with synovial membrane, but they are here separated by an intervening plate of fibro-cartilage (*Interarticular Fibro-cartilage*). This plate or disk is transversely oval, thick at its circumference, but thin and often perforated at its middle. Its two surfaces are smooth and free, and accommodate themselves to the shape of the surfaces with which they are in contact. The fibres of which it is composed are very close, and disposed in a concentric manner. When the interarticular fibro-cartilage is not perforated, there are two separate synovial membranes in the joint, one above and the other below, of which the inferior is not so loose as the superior, so that the plate is more closely applied to the condyle than to the glenoid cavity.

The special extrinsic means of union consist really of a capsular membrane and one ligament, namely, the external lateral; but anatomists generally describe an internal lateral and a stylo-maxillary ligament as also forming a part of the articulation.

The *External Lateral Ligament* is a thick band extending from the tubercle, at the junction of the two roots of the zygoma, backward and downward to the outside of the neck of the condyle. Its external sur-

face is attached to the skin, and its internal to the interarticular fibro-cartilage and the two synovial sacs.

The *Internal Lateral Ligament* is a thin band of dense fascia, extending from the spinous process of the sphenoid bone to the little process which forms the internal edge of the superior orifice of the dental canal. Its main use seems to be to protect the dental vessels and nerves, which are situated between it and the neck of the lower jaw.

The *Stylo-maxillary Ligament* is a fold of the deep cervical fascia, connected above to the styloid process, and below to the angle of the jaw.

The *Capsular Membrane,* loose and thin, is attached to the edge of the glenoid cavity and tubercle above, and the neck of the inferior maxillary below.

ARTICULATIONS OF THE THORAX.

These consist of the union of the ribs with the bodies and transverse processes of the dorsal vertebræ, and, in front, with the costal cartilages, and through them with the sternum; also of the junction of the cartilages of the false ribs with each other.

Costo-vertebral Articulations.—These are double diarthrodial articulations. Each rib is joined by its head to the pit upon the sides of the bodies of the vertebræ, and, by its tubercle, to the summit of the transverse process of the vertebra below.

The former of these articulations, that between the head of the rib and the bodies of the vertebræ, is maintained: 1, by an *Anterior* or *Stellate Ligament,* whose fibres are collected into three bundles that diverge from the head of the rib and are inserted, one into the body of the upper of the two vertebræ upon which the articular facet is situated, one to the vertebra below, and the third or middle one to the intervertebral fibro-cartilage; 2, by an *Interarticulate Ligament,* which consists of a short thin bundle of fibres, extending between the projecting ridge upon the head of the rib to the intervertebral substance at the bottom of the pit. This ligament divides the articulation into two parts, each of which is provided with a separate synovial membrane.

The union between the rib and the transverse process, called the *Costo-transverse Articulation,* is maintained by three ligaments, also named costo-transverse, and distinguished by their position into an anterior, middle, and posterior. The *Anterior Costo-transverse Ligament* extends obliquely from the inferior edge of each transverse process to the superior edge of the neck of the rib below. It seems often to consist of two or more bundles, and is properly only a continuation of the aponeurosis which covers the external intercostal muscle, and separates the anterior and posterior branches of the intercostal vessels and nerves. The *Middle or Interosseous Costo-transverse Ligament* consists of a number

of short but very strong bundles of fibres, stretched between the anterior surface of the transverse process and the posterior surface of the neck of the rib. The strength of the costo-vertebral articulations is mainly due to this ligament, which forms a sort of amphiarthrodial articulation between the surfaces which it connects. The *Posterior Costo-transverse Ligament* is a short thick band of fibres, extending from the summit of the transverse process to the outer margin of the tubercle of the corresponding rib.

The heads of the first, eleventh, and twelfth ribs being received into cavities formed respectively upon only one vertebra, the interarticular ligament is here wanting, and, in the case of the last two, there is also no costo-transverse articulation, but a middle costo-transverse ligament.

Costo-sternal Articulations.—The true ribs are joined to the lateral margins of the sternum, through the intervention of their costal cartilages, the anterior extremities of which are received into corresponding pits, a true diarthrodial synovial membrane intervening. The means of union consist of an anterior and a posterior ligament.

The *Anterior Costo-sternal* or *Chondro-sternal Ligament* is composed of thin scattered fibres, which radiate from the anterior edge of the extremity of each cartilage, and become blended with the fibrous covering of the corresponding surface of the sternum, and with the sternal attachment of the great pectoral muscle. The *Posterior Ligament* is like the anterior, but its fibres are less numerous.

The presence of a synovial membrane can be almost always readily demonstrated in all of the articulations, except the first; here the cartilage is often continuous with the sternum without any such provision.

Besides the ligaments already mentioned, the sixth and seventh cartilages possess a thin triangular layer of fibres, which connects them to the ensiform or xiphoid cartilage, and is hence called the *Costo-xiphoid Ligament.*

Articulation of the Costal Cartilages with each other.—The costal cartilages, from the sixth to the ninth inclusive, are joined together by an anterior and a posterior vertical bundle of fibres, of which the former is much the thicker and stronger. Between the contiguous surfaces are distinct synovial membranes.

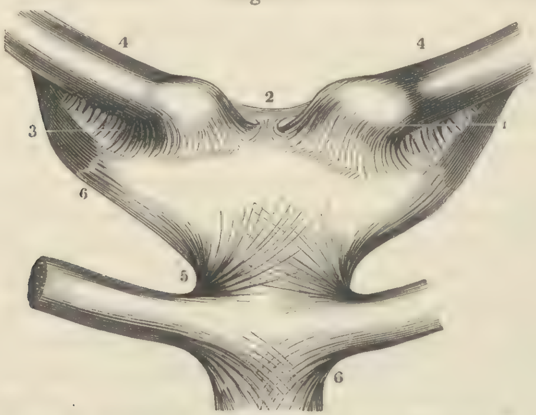
ARTICULATIONS OF THE SUPERIOR OR THORACIC EXTREMITIES.

The bones of the shoulder, the first division of the upper extremity, form but one articulation with the trunk, the sterno-clavicular; one with each other, the acromio-clavicular; and one with the arm bone, the scapulo-humeral articulation or shoulder joint.

The remaining articulations of this extremity are the elbow joint, the wrist joint (including the junction of the bones of the wrist with each other, with the bones of the forearm, and with the metacarpal bones), and, lastly, the several joints of the fingers and thumb.

The Sterno-clavicular Articulation is diarthrodial, and belongs to that variety in which there is a mutual reception of the opposed bones. It is remarkable, also, for the crucial disposition of the long diameters of the two surfaces, the end of the clavicle presenting its long diameter from before backward, and the notch of the sternum from within outward. Like the temporo-maxillary, this articulation is divided into two parts by an interarticular plate of fibro-cartilage, each division being provided

Fig. 111.



Sterno-clavicular and costo-sternal articulations. 1, capsular ligament; 2, interclavicular ligament; 3, costo-clavicular or rhomboid ligament; 4, 4, clavicles; 5, 6, costo-sternal or chondro-sternal ligaments.

with a separate synovial membrane. The *Interarticular Fibro-cartilage* is thick toward the edges, but thin and sometimes perforated at the centre. By its superior posterior edge it is attached to the corresponding margin of the articular surface of the clavicle, and by its inferior to the margin of the surface of the sternum, near the insertion of the cartilage of the first rib.

The means of union consist of a capsular, an interclavicular, and a costo-clavicular ligament.

The *Capsular Ligament* is a fibrous bag or capsule which surrounds the whole joint. Its fibres extend from the circumference of the end of the clavicle to the margins of the articular notch of the sternum. It is thinner and looser in front than behind, which Cruveilhier thinks may partly account for the more frequent dislocations of this end of the clavicle forward.

The *Interclavicular Ligament* is a tolerably thick fibrous band, extending between the superior posterior margins of the inner ends of the clavicles, and attached by its middle to the back part of the middle notch or *fourchette* of the sternum.

The *Costo-clavicular Ligament,* although not in immediate connection with the joint, assists materially in binding the bones together. It is short but of considerable thickness and strength, and extends from the cartilage of the first rib obliquely upward and outward, to the inner side of the rough tubercle upon the under surface of the clavicle. The outer side of this tubercle is smooth, and often furnished with cartilage and synovial membrane for articulation with the upper surface of the first rib.

The Acromio-clavicular Articulation.—This articulation is formed between the outer extremity of the clavicle and the anterior margin of the acromion process. The articular surfaces are elliptical, and vary in size in different individuals, according to the amount and nature of exercise to which the corresponding arm has been accustomed. Between the surfaces is sometimes found a small interarticular fibro-cartilage.

The means of union consist of a fibrous capsule, which is thick and strong above, but thin and membranous below. Besides this, the bones are bound together by a strong ligament extending from the under and posterior surface of the clavicle to the coracoid process, and hence called the *Coraco-clavicular Ligament.* It is divided into two parts or bundles, distinguished from each other by the names conoid and trapezoid, terms expressive of their respective shapes. The former, the *conoid,* is posterior, nearly vertical, and attached by its lower extremity to the base of the coracoid process. The *trapezoid* is oblique in its direction, attached by one extremity to the inner edge and base of the coracoid process, and by the other, to the ridge on the lower surface of the clavicle near its outer end. The two are united by their posterior borders, and when viewed from behind appear as one.

The Scapulo-humeral Articulation or Shoulder Joint.—This articulation is one of the most interesting articulations in the body, both on account of the latitude and perfection of its movements, and the frequent accidents to which it is subject. The opposed surfaces, the small shallow glenoid cavity of the scapula and the large hemispherical head of the humerus, seem greatly out of proportion, and offer no mechanical conformation whatever for the security of the joint, but are held together entirely by the capsular ligament and the surrounding muscles, the tendons of some of which, in fact, form a part of the ligament. The joint is also protected above by the acromion and coracoid processes, and by the *Coraco-acromial Ligament.* The latter is a dense, triangular band, which spans the interval between the acromion and coracoid process, and,

resting like an arch above the joint, prevents dislocation of the humerus in this direction.

Another structure, forming an integral part of the articulation, is the *Glenoid Ligament*, which consists of a bundle of tendinous fibres surrounding and closely attached to the circumference of the glenoid surface, thus increasing its diameters nearly half an inch, and deepening its concavity. This ligament is continuous superiorly with the tendon of the long head of the biceps muscle, which here bifurcates, and cannot be distinguished from the ligament itself.

Fig. 112.

Scapulo-clavicular and scapulo-humeral articulations. 1, acromio-clavicular articulation, surrounded with its capsular ligament; 2, coraco-clavicular ligament; 3, coraco-acromial ligament; 4, coracoid ligament; 5, capsular ligament of shoulder joint; 6, coraco-humeral ligament; 7, tendon of biceps flexor muscle.

The *Capsular Ligament* is attached by one extremity to the circumference of the glenoid cavity just behind the glenoid ligament, and, by the other, to the circular groove (anatomical neck) which limits the articular head of the humerus. It is loose and thin below, but thick and strong throughout the rest of its extent, where it is blended with the tendons of the long head of the triceps, the subscapular, supraspinous, infraspinous, and small teres muscles. It is also strengthened above and in front by a bundle of fibres called the *coraco-humeral ligament*, which originates from the coracoid process, and spreads out upon the surface of the capsular ligament. If the tendons of the surrounding muscles be divided, the laxity of the capsular ligament allows the humerus to fall away from the glenoid surface to the distance of nearly half an inch. It is, therefore, of but little service in keeping the bones in apposition, being intended mainly for the support of the synovial membrane. The strength and security of the joint depend upon the muscles above mentioned, which are closely applied to it on all sides and are inserted into the tuberosities of the humerus immediately adjacent to the head of the bone. The long tendon of the biceps, which passes through the upper part of the joint, also contributes largely to the same end.

The synovial membrane lines the internal surface of the capsular ligament, and, where this is deficient, the tendons of some of the muscles already mentioned, particularly the subscapular; upon the surface of the latter, it is prolonged a short distance along the inner side of the root of the coracoid process, thus forming a gliding surface for the tendon to play

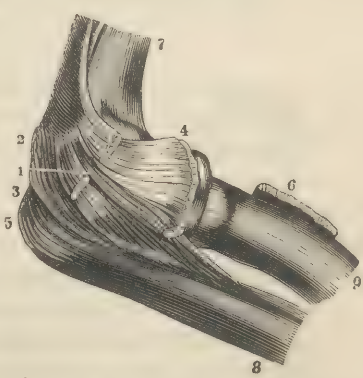
upon. Instead, however, of a prolongation of the synovial membrane, a separate synovial sac or mucous bursa is sometimes found occupying this situation. The long tendon of the biceps, where it lies within the joint, is furnished with a tubular investment by the membrane, which is sometimes continued along the same into the bicipital groove of the humerus.

The movements of which the shoulder joint is susceptible are flexion, extension, adduction, abduction, rotation, and complete circumduction, all of which may be carried to a degree surpassing any other joint in the body.

The Elbow Joint.—The surfaces entering into this articulation are the lower end of the humerus, the greater sigmoid notch of the ulna, and the cup-shaped excavation upon the head of the radius. The opposition between the humerus and ulna (*humero-ulnar articulation*) is a true ginglymus, and that between the humerus and radius (*humero-radial articulation*) belongs to the ball-and-socket variety; both, however, constitute but one joint. The ligaments binding the bones together are four in number, two lateral, an anterior, and a posterior, which are all continuous with each other at their edges, and thus form an imperfect capsule.

The *Internal Lateral Ligament* consists of two triangular bundles of fibres, one placed anteriorly and the other posteriorly, the former extending from the internal condyle in front to the whole length of the internal side of the coronoid process of the ulna, and the latter from the posterior part of the condyle to the whole extent of the internal margin of the olecranon. The *External Lateral Ligament*, also triangular, is attached above to the external condyle of the humerus, and below is blended with the annular ligament that surrounds the head of the radius. Both of these lateral ligaments are intimately connected with the origins of the flexor and extensor muscles of the forearm.

Fig. 113.



Elbow joint. 1, external lateral ligament, blended with extensor tendons; 2, 3, 5, posterior ligament; 4, annular ligament; 6, tendon of biceps; 7, humerus; 8, ulna; 9, radius.

The *Anterior Ligament* is thin and membranous, and consists of fibres which cross each other obliquely and at right angles; it extends from the upper margin of the coronoid cavity to the lower part of the coronoid process, and is connected externally with the annular ligament of the radius. The *Posterior Ligament* consists of a few scattered fibres stretched between the upper and lateral margins of the olecranoid cavity

to the apex and sides of the olecranon process; it hardly deserves the name of a ligament.

These two ligaments seem only intended to cover the joint in front and behind, and to support the synovial membrane; the strength of the joint in these situations depends entirely upon the anterior brachial and the triceps muscles.

The synovial membrane lines the internal surface of the capsule formed by the four ligaments, and is prolonged into the articulation between the head of the radius and the smaller sigmoid notch of the ulna, lining the internal surface of the annular ligament, and investing the lower circumference of the head of the radius.

The movements of the humero-ulnar articulation are only flexion and extension, the former limited by the contact of the coronoid process with the coronoid cavity on the humerus, and the latter by that of the olecranon with the olecranoid cavity. In these movements the radius is, of course, carried in the same direction, its cup-shaped cavity resting against the small head of the humerus.

Superior Radio-ulnar Articulation.—This articulation is formed between the circumference of the head of the radius on the one hand, and the lesser sigmoid notch and annular ligament upon the other.

The *Annular* or *Orbicular Ligament* is a flattened but tolerably thick band of fibres which encircles the circumference of the head of the radius, and is attached by its extremities to the anterior and posterior terminations of the smaller sigmoid notch. It forms about three-fourths of a circle, the deficiency being filled out by the articular surface upon the bone, and is somewhat constricted at its lower border so as to grasp the neck of the radius. It is lined internally by a prolongation of the synovial membrane of the elbow joint, and blended externally with the insertion of the external lateral ligament and the origins of the extensor muscles of the hand.

Fig. 114.

1, articular surface of olecranon process of ulna; 2, coronoid process; 3, orbicular ligament surrounding neck of radius.

The only movement of which this joint is susceptible is that of rotation, in the performance of which the cavity upon the head of the radius revolves upon the small head of the humerus as upon a pivot, and the carpal extremity of the bone is made to describe the segment of a circle upon the head of the ulna as its centre, thus pronating and supinating the hand.

The Inferior Radio-ulnar Articulation.—The inferior extremities of the radius and ulna are joined together very much in the same manner as the superior; but here (in the inferior articulation) the position of the surfaces is reversed, the cavity is upon the inner side of the extremity of the radius and receives the outer border of the head of the ulna. There is, however, no true annular ligament, but in its place an anterior and a posterior set of ligamentous fibres, extending from the extremities of the semilunar excavation on the radius to the anterior and posterior surfaces of the extremity of the ulna, where they are attached, and also short and strong interosseous fibres immediately above the articulation.

Besides the transverse ligaments, there is another and a very different structure uniting the two bones. This is the *Triangular Cartilage*, which, as its name indicates, is a triangular-shaped plate of cartilage, or rather fibro-cartilage, situated below the head of the ulna, and extending from the base of the styloid process, where it is attached by one angle, to the lower margin of the crescentic notch, and is here continuous with the articular cartilage on the lower extremity of the radius. It is tolerably thick near the styloid process, but becomes thin toward its radial attachment. Besides assisting in binding the two bones together, it performs the office of an interarticular cartilage in breaking the force of shocks, etc., and, "above all, it restores the level of the inferior radio-ulnar surface, by filling out the deficiency formed by the projection of the radius below the ulna."

The synovial membrane is situated between the triangular cartilage and the head of the ulna, and is prolonged upward between the opposed surfaces of the articulation. It has no connection or communication with the synovial membrane of the radio-carpal joint.

The only movement that takes place in this joint is rotation, in which the lower extremity of the radius revolves upon the head of the ulna, thus producing pronation and supination of the hand.

The Middle Radio-ulnar Articulation.—The long narrow space between the radius and ulna is occupied by an aponeurotic membrane, the *Interosseous Membrane*, which not only binds the bones together but gives origin to muscles. It is broadest in the middle, and is deficient above and below for the passage of bloodvessels and nerves. Its fibres run for the most part obliquely downward and inward from the radius to the ulna, but, superiorly, there is a single band, improperly called the *Round Ligament*, which is stretched from the outer side of the coronoid process of the ulna to the lower part of the tuberosity of the radius.

The Radio-carpal Articulation or Wrist Joint.—The structures composing this articulation consist of a transversely oval, concave surface,

formed upon the lower extremity of the radius and the lower surface of the triangular fibro-cartilage, and of a transversely elongated head or condyle, formed by the first three bones of the superior row of the carpus. The parts are united by four ligaments, two lateral, an anterior, and a posterior; these, however, are all continuous with each other at the margins, thus forming a true capsule.

The *Internal Lateral Ligament* is a tolerably thick rounded cord, which extends from the outer side of the styloid process of the ulna to the posterior surface of the cuneiform bone, some of its fibres diverging to the pisiform. The deep surface of this ligament is covered by the synovial membrane of the joint. The *External Lateral Ligament*, thinner but broader than the preceding, is attached above to the styloid process of the radius, and below to the outer side of the scaphoid bone.

The *Anterior Ligament* is thin and membranous, and is divided into several separate bands by openings occupied by bloodvessels, and by adipose and areolar tissue. It is attached above to the anterior margin of the lower extremity of the radius, and below to the first row of carpal bones, the fibres being directed obliquely from above downward and inward. A separate ligament is sometimes described as originating by a small extremity from the neighborhood of the base of the styloid process of the ulna, and passing obliquely downward and outward to be inserted broadly into the scaphoid bone. The *Posterior Ligament* is thinner and narrower than the anterior. It stretches from the posterior border of the lower extremity of the radius, to the corresponding surfaces of the cuneiform and semilunar bones. This ligament cannot be separated from the sheaths of the tendons which pass along the posterior surface of the carpus.

Besides these four ligaments, the tendons of the flexor and extensor muscles perform a very essential part in giving strength to the articulation.

The synovial membrane lines the internal surfaces of the surrounding ligaments, but extends no farther than the articular surfaces.

The movements are principally flexion and extension, with a slight degree of adduction and abduction.

The **Intercarpal Articulations** are divisible into the articulations of the bones of each row, and of one row with the other.

The first three bones of the first row are bound together by interosseous fibro-cartilage, and by palmar and dorsal ligaments.

The *Interosseous Fibro-cartilage* is situated upon each lateral surface of the semilunar bone, so as to connect this bone with the scaphoid upon one side, and the cuneiform upon the other. It consists of small fibrous bundles of a reddish color, and long enough to permit some degree of gliding between the opposed surfaces.

The *Palmar* and *Dorsal Ligaments* are bands of fibres, extending transversely from the cuneiform bone to the one on each side, upon the anterior and posterior aspects of the carpus.

The pisiform bone is placed in front of the cuneiform, to which it is articulated by a single facet, a small isolated synovial sac intervening. Its means of attachment are numerous small interosseous fasciculi of fibres, and two distinct ligaments, one of which extends to the process of the unciform, and the other to the base of the fifth metacarpal bone.

The four bones of the second row are joined together like the first three of the first row, but their union is much more compact, on account of the greater density and shortness of the interosseous fibres.

The palmar and dorsal ligaments are three in number, of which, as is the case in the first row, the former are thicker and stronger.

The articulation of the two rows is a kind of mutual dovetailing, the head of the magnum being received into a concavity formed by the scaphoid and semilunar, and the lower extremity of the scaphoid into a smaller excavation formed by the trapezium, trapezoid, and magnum. They are united by four sets of ligaments, one anterior, one posterior, and two lateral. The *Lateral Ligaments* are situated, respectively, upon the radial and ulnar borders of the carpus, the external stretching from the scaphoid to the trapezium, and the internal from the cuneiform to the unciform. The *Anterior* or *Palmar Ligament*, thick and strong, consists of radiating fibres extending from the first three bones of the first row to the magnum. The *Posterior* or *Dorsal Ligament* is not well defined, being composed of scattered fibres running from one row to the other.

The articulations of the carpal bones are each furnished with a prolongation of one common synovial sac. This is placed between the two rows, and sends little sacculated processes between the several bones, two for the first and three for the second row. The latter communicate with the synovial sac of the carpo-metacarpal articulation, and the former also sometimes with the sac of the radio-carpal. As before mentioned, the sac between the pisiform and cuneiform bones is entirely distinct.

The Carpo-metacarpal Articulations.—The articulation between the trapezium and the first metacarpal bone belongs to that class in which there is a mutual reception of the opposed surfaces.

The means of union, besides the surrounding tendons, which give very material aid, consist of a well-formed capsular ligament and a separate synovial membrane, both of which are sufficiently loose to permit all the motions except rotation.

The articulation between the remaining four metacarpal bones and the corresponding parts of the carpus is also diarthrodial, but so close as to allow only the slightest degree of motion. The line of contact between the opposed surfaces is made irregular by the second metacarpal bone

being received into a mortiselike notch formed by the trapezium, trapezoid, and magnum.

The ligaments are intrinsic and extrinsic. The former are placed upon the dorsal and palmar aspects of the hand, and consist of numerous bands, of which some are oblique and others vertical; the latter are short, thick, interosseous fibres, running between the nearest parts of the opposed surfaces.

The synovial membrane, continuous with that between the two rows of the carpal bones, follows the irregular line of the articulation, and is prolonged between the contiguous sides of the corresponding extremities of the metacarpal bones.

The first of these articulations, that between the trapezium and the metacarpal bone of the thumb, differs essentially from all the others in the character of the opposed surfaces and the extent of its movements. The surface upon the trapezium is convex antero-posteriorly and concave transversely, and that upon the corresponding extremity of the metacarpal bone concavo-convex in opposite directions, so that there is a mutual interlocking. The means of union are a loose but strong capsular ligament, and the joint possesses all the different movements, except rotation, in a remarkable degree.

Metacarpal Articulations.—The Metacarpal Bones are articulated with each other, both at their carpal and phalangeal extremities. In the former situation the articular surfaces are small, irregular facets, covered with cartilage and provided with prolongations of the carpo-metacarpal synovial membrane. They are united by three transverse fibrous bands upon the palmar and dorsal surfaces, and numerous short interosseous bands passing directly between the contiguous parts around the articular facets. The lower or phalangeal extremities of the bones are simply bound together, without a true articulation. The ligaments are thin fibrous bands placed upon the palmar aspect, and numerous interosseous bundles. The former constitutes what is called the *Transverse Ligament.*

The Metacarpo-phalangeal Articulations.—These articulations are five in number, and are all exactly alike.

The head of each metacarpal bone is flattened from side to side, and its articular surface elongated from before backward, and prolonged much farther upon the palmar than upon the dorsal aspect of the bone. The metacarpal extremity of the first phalanx presents a shallow, transversely-oblong depression, slightly deepened in the recent state by the incrusting cartilage, which is thicker at the circumference than at the centre.

The ligaments are three in number, two lateral and an anterior. The *Lateral Ligaments* are very strong, flat, and glistening, and radiate obliquely forward from the tubercle and depression on each side of the head

of the metacarpal bone, to corresponding tubercles upon the sides of the superior extremity of the first phalanx. The *Anterior Ligament* is dense and thick, and occupies the space between the two lateral in front. The movements of the joints are flexion and extension with more or less abduction and adduction.

The Phalangeal Articulations.—These belong to the class of angular ginglymus, and are nine in number, namely: two for each finger and one for the thumb. The articular surface upon the distal end of each phalanx is flattened from before backward, and presents two small tubercles or condyles, separated by a slight antero-posterior groove; and the superior extremity of the bone beyond has two corresponding depressions with an intervening ridge. The ligaments are three in number, two lateral and an anterior, and do not differ materially in their arrangement from those of the metacarpo-phalangeal articulation.

ARTICULATIONS OF THE INFERIOR EXTREMITIES.

These articulations include those of the pelvic bones with each other and with the sacrum, the coxo-femoral articulation or hip joint, the knee joint, and the articulation of the bones of the leg and foot.

The Innominate or Hip Bones form the lateral and anterior walls of the pelvis, and are articulated to the sacrum, to each other, and to the femurs.

The Sacro-Iliac Articulation or Symphysis (Figs. 115 and 116).—This belongs to the amphiarthrodial class of articulations, but the motion is very slight, and many anatomists deny its existence altogether.

The opposed surfaces are auricular or ear-shaped, very uneven, and incrusted with a thin layer of fibro-cartilage, which is thicker upon the sacrum than upon the ilium. From the corresponding surfaces, when the joint is laid open, there may be scraped a small quantity of soft, yellowish gelatinous substance, which bears a very close resemblance to the semifluid substance in the centre of the intervertebral disks. The ligaments are the sacro-iliac and the sacro-ischiatic.

The *Sacro-iliac Ligaments* are situated in front of and behind the joint. The *anterior* set consists of a few irregular fibres, forming a short, thin band, which is stretched between the anterior margins of the two articular surfaces. The *posterior* set is composed of numerous oblique and transverse bands, which extend between the opposite rough surfaces of the ilium and sacrum behind the articulation, and fill up the deep part of the groove between the two bones; they are very dense and strong, and upon them almost the whole strength of the articulation depends. One of these bundles, more superficial than the others, and extending from the posterior superior spine of the ilium to the lower part of the spine of the sacrum, is known as the *Oblique* or *Posterior Sacro-iliac Ligament.*

The sacro-ischiatic or sciatic ligaments, two in number, are not immediately connected with the articulation, but, nevertheless, add very much to its strength.

The *Great Sacro-ischiatic Ligament* is situated at the lower back part of the pelvis, and extends from the posterior part of the iliac crest, the margin, and spine of the sacrum, and from the border of the coccyx to the inner side of the tuberosity of the ischium. It is triangular in shape, flattened from within outward, and consists of closely applied fibres, which converge from its internal broad extremity toward its insertion into the ischium. It is in relation, behind, with the great gluteal muscle, to a large part of which it gives origin, and, in front, to the small sacro-ischiatic ligament, with which it is continuous at its internal extremity, and from which it is separated externally by a triangular-shaped opening, known as the small sacro-ischiatic foramen.

The *Small Sacro-ischiatic Ligament* is situated in front of the preceding, and in common with it originates broadly from the lower part of the margin of the sacrum, and is inserted into the extremity of the spinous process of the ischium. It is also triangular, flattened from within outward, and directed a little obliquely outward, and downward toward its insertion.

By means of these two ligaments, the sacro-ischiatic notch is converted into two foramina, called the *great* and *small sacro-ischiatic foramina.* The former of these openings is large, somewhat triangular, and bounded *behind* by the border of the sacrum below the sacro-iliac symphysis, *in front* by the posterior margin of the body of the ischium, and, *below*, by the superior edge of the smaller ligament. It gives passage to the pyriform muscle, the gluteal vessels and nerves, the great and small sciatic nerves, the sciatic artery, and the internal pudic artery, with its accompanying nerve. The small foramen, also triangular, is formed by the diverging borders of the two ligaments and the body of the ischium, between its spine and tuberosity, and is occupied by the tendon of the internal obturator muscle, which glides over this part of the ischium as upon a pulley; and by the internal pudic artery and nerve, which here re-enter the pelvic cavity, having passed out of it through the larger opening.

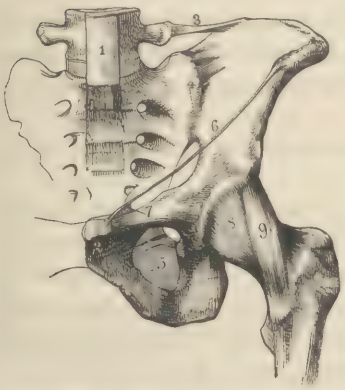
The **Pubic Articulation**, commonly called the *pubic symphysis* (Fig. 115, $_2$), is amphiarthrodial, and occurs between the internal extremities of the pubic bones, each of which presents a plane, vertically oval surface, cut, as it were, obliquely from behind forward and outward, so that the thickness of the interval occupied by the fibro-cartilage is greater in front than behind. The bones are bound together by intervening fibro-cartilage and four extrinsic ligaments.

The plate of fibro-cartilage which fills up the interval between the bones

is wedge-shaped, its broad edge presenting forward. Its structure is precisely similar to that of the intervertebral disks.

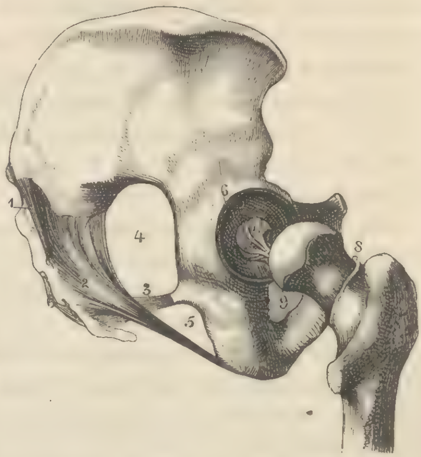
The ligaments are: 1, an *anterior*, consisting of scattered oblique and transverse fibres, forming a broad thin membranous band, which extends between the anterior edges of the articular surfaces; 2, a *posterior*, like the preceding, but thinner and more difficult of demonstration; 3, a *superior*, thin, narrow, very indistinct, and continuous with the periosteum on each side; 4, an *inferior*, the triangular or subpubic ligament, thick and strong, flattened from before backward, triangular and composed of fibres stretched transversely between the sides of the angle of the pubic arch.

Fig. 115.



Ligaments of pelvis and hip joint. 1, lower part of anterior vertebral ligament; 2, pubic symphysis; 3, ilio-lumbar ligament; 4, sacro-iliac symphysis, with anterior sacro-iliac ligament; 5, obturator membrane; 6, edge of tendon of external oblique muscle of abdomen, technically named Poupart's ligament; 7, extension of latter along pectineal line named Gimbernat's ligament; 8, capsular ligament of hip joint; 9, strong accessory band of latter ligament.

Fig. 116.



Ligaments of pelvis and hip joint. 1, posterior sacro-iliac ligament; 2, great sacro-sciatic ligament; 3, small sacro-sciatic ligament; 4, great sacro-sciatic foramen; 5, small sacro-sciatic foramen; 6, cotyloid ligament surrounding border of acetabulum; 7, round ligament; 8, cut edge of capsular ligament; 9, obturator membrane.

The Coxo-femoral or Hip Joint (Figs 115 and 116).—This is a true ball-and-socket joint. The opposed surfaces are the acetabulum or cotyloid cavity and the head of the femur, which have already been described in connection with the bones to which they belong; but in the recent state they present certain modifications which should be carefully noticed.

The head of the femur is incrusted with a layer of cartilage, which is much thicker above than below, being sometimes almost entirely wanting in the latter situation. The cotyloid cavity is also lined with cartilage, which is thickest near the margins, and entirely wanting at the bottom, where the depression exists for the attachment of the round ligament and

the lodgment of adipose tissue. This cavity is also surrounded and deepened about one-third of an inch by a fibrous ring called the *Annular* or *Cotyloid Ligament*, which is attached to the whole extent of its margin, and converts the notch below into a foramen, for the transmission of the vessels of the joint. The ligament is triangular prismatic, thicker above than below, and consists of closely interlaced fibres of various lengths, which arise from the bony margin at different points, and are again inserted into it.

Besides the mechanical arrangement of the surfaces for keeping the bones in place, which is superior to that of any of the other large joints of the body, the articulation is provided with a capsular and an interarticular or round ligament.

The *Capsular Ligament* represents a transverse section of a large membranous tube, which is attached by one extremity to the circumference of the acetabulum just outside the cotyloid ligament, and by the other to the anterior intertrochanteric line of the femur in front, and behind to the neck of the bone at the junction of its external third with its internal two-thirds. A transverse division exhibits a remarkably dense structure, at least a quarter of an inch in thickness above, where the greatest strength is required, but not more than half so much below. It is also strengthened above and in front by a band of fibres extending from the anterior inferior iliac spine to the base of the neck of the femur in front, which, although not in fact a separate structure, is called the *Ilio-femoral Ligament.*

The external surface of the capsular ligament is rough where it is in contact with the surrounding muscles; internally, it is lined by the synovial membrane. When cleanly dissected, it does not present the pearly glistening appearance of fibrous structures generally, but is of a dull opaque white color. Owing to the closeness with which it holds the bones together, it is necessarily lacerated or torn from its attachments in dislocations of the joint.

The *Interarticular Ligament*, commonly called the *round ligament*, is a thick, dense, cordlike bundle of fibres, extending from the pit on the head of the femur to the bottom of the cotyloid cavity, where it divides into two slips, which are inserted respectively into the margins of the notch below. When the articular surfaces of the bones are in contact, this ligament is lodged in the depression at the bottom of the cavity, so as not to interfere with the movements of the joint. Its only use seems to be that of a support to the vessels which go to and come from the head of the femur, for it is too long to take any part in maintaining the bones in contact. It varies considerably in shape and size, and is sometimes entirely wanting.

The synovial membrane invests the cotyloid ligament and the internal surface of the capsular ligament, covers nearly the whole of the neck of

the femur in front, and two-thirds of it behind, forms a tubular investment for the interarticular ligament, and at the bottom of the acetabulum spreads out upon the mass of adipose substance found in this situation. It frequently forms around the neck of the femur little fringelike folds, whose office is not positively ascertained.

Another structure connected with the hip joint is the mass of fat situated in the depression at the bottom of the cotyloid cavity. This seems to perform no particular office, except that of filling up that part of the depression not occupied by the interarticular ligament.

The motions of the hip joint are flexion, extension, abduction, adduction, rotation, and circumduction.

The Femoro-tibial Articulation or Knee Joint.—This, the most complicated articulation in the body (Figs. 117, 118, and 119), is an angular ginglymus. The opposed surfaces are: 1, the two condyles of the femur, which form a pulleylike surface in front, but are separated behind by the intercondyloid notch; 2, the two shallow concavities of the tibia with the intervening spine; and 3, the posterior face of the patella, divided by a vertical ridge into two lateral superficial concavities. These surfaces are well protected by incrusting cartilage, and bound together by strong extrinsic and intrinsic ligaments. Between the condyles of the femur and the tibia are two interarticular cartilages, called the semilunar cartilages. The extrinsic ligaments are two lateral, an anterior and a posterior; the intrinsic are an anterior and a posterior crucial.

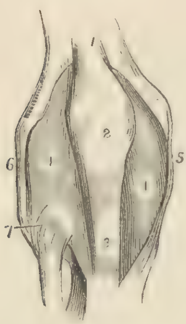
The *External Lateral Ligament* is a well-defined rounded cord, extending from a small eminence upon the outer side of the corresponding condyle of the femur, to the external surface of the head of the fibula. It is vertical, lies parallel to, and directly in front of the tendon of the biceps muscle, and is in close contact above with the popliteus muscle, which originates from a small pit just below the above-mentioned eminence.

The *Internal Lateral Ligament* is broad and thin, and extends from the outer back part of the internal condyle of the femur to the inner margin of the head of the tibia. Its tibial attachment is broad, and is covered by the tendons of the sartorius, gracilis, and semitendinous muscles, a synovial bursa intervening. It is connected by its deep surface to the synovial membrane of the joint and the internal semilunar cartilage.

The *Posterior Ligament* (ligament of Winslow), commonly considered as a reflected portion of the tendon of the semimembranous muscle, is a flattened band of ligamentous fibres, extending from the back part of the external condyle of the femur to the internal tuberosity of the tibia, crossing the back part of the articulation obliquely, and continuous at its attachment to the tibia with the before-mentioned tendon.

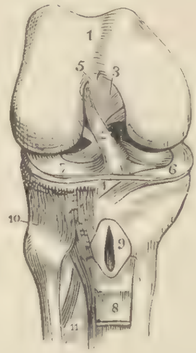
The *Anterior Ligament* is composed of the common tendon of the extensor muscles of the leg, the patella, and the patella ligament. The

Fig. 117.



Anterior view of ligaments of knee joint. 1, tendon of extensor muscle of leg; 2, patella; 3, patella ligament near its insertion; 4, 4, capsular membrane; 5, internal lateral ligament; 6, long external lateral ligament; 7, anterior superior tibio-fibular ligament.

Fig. 118.



Right knee joint laid open from the front. 1, cartilaginous surface of lower extremity of femur with its two condyles; figure 5 rests upon external, figure 3 upon internal condyle; 2, anterior crucial ligament; 3, posterior crucial ligament; 4, transverse ligament; 5, attachment of adipose ligament; 6, internal, 7, external semilunar cartilage; 8, part of patella ligament turned down; 9, bursa between patella ligament and head of tibia, laid open; 10, anterior superior tibio-fibular ligament; 11, upper part of interosseous membrane; opening above this membrane is for passage of anterior tibial artery.

first and last of these three structures are properly continuations of each other, the intervening patella being only a sesamoid bone developed in the substance of the tendon.

The *Patella Ligament* (ligamentum patellæ), considered as a separate structure, is broad and thick, attached above to the apex and anterior surface of the patella, and below to the lower part of the anterior tuberosity of the tibia. It is subcutaneous in front, and in relation behind with a mass of fat which separates it from the cavity of the joint, and below this point with a large synovial bursa, that intervenes between it and the prominent part of the anterior tuberosity of the tibia.

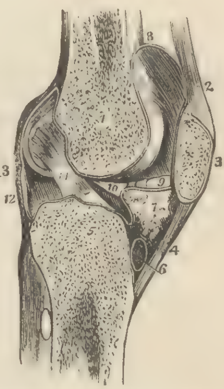
A strong fibrous expansion, constituting a capsular ligament, fills up the intervals between these four ligaments, connecting them together and supporting the synovial membrane. Posteriorly, where it covers the condyles, this membrane is wanting, but here the heads of the gastrocnemius muscle make up the deficiency. It is also continuous with the fascia of the thigh and the fibrous expansion of the triceps extensor muscle.

The *Crucial* or *Interarticular Ligaments* are placed deep within the joint. They are very strong, and so arranged as to be relaxed by flexion of the leg, and tightened by extension. They are two in number, an anterior and a posterior, and, as their name (crucial) implies, cross each other

in their direction. The *anterior* arises from a depression upon the middle of the internal surface of the external condyle of the femur within the intercondyloid notch, and, descending obliquely downward, inward, and forward, is implanted into the front of the interarticular spine of the tibia. The *posterior* arises from the external surface of the internal condyle, opposite the preceding, descends downward, backward, and outward, and is inserted into the pit behind the spine of the tibia; it is less oblique than the anterior, but sufficiently so to form with it an oblique antero-posterior crossing.

The *Interarticular Cartilages*, two in number, are situated between the condyles of the femur and the concave surfaces of the tibia. They serve as a cushion to break the ordinary pressure of the body above, and also that produced by sudden falls or blows upon the leg below. From their crescent shape they are commonly called semilunar cartilages. They have a superior concave and an inferior plane surface, a thick, semicircular, external, and a thin, sinuous, internal edge. The *internal* of the two cartilages is elongated from before backward, and is distinctly semilunar; it is attached by an anterior ligament to the front of the spine of the tibia, and, by a posterior, to a roughness behind the insertion of the posterior crucial ligament. The *external* cartilage is more nearly circular, is connected in front and behind with the insertions of the crucial ligaments, and has also an anterior and a posterior ligament which attach it to the corresponding parts of the spine of the tibia. The latter are placed between the ligaments of the internal cartilage, and are, therefore, quite near each other. A small band of fibres, forming what is called the *transverse ligament*, connects the anterior extremities of the cartilages in front of the spine of the tibia. They are also connected to the corresponding lateral ligaments of the joint; and the external of the two is slightly grooved upon its margin behind for the tendon of the popliteus muscle, which crosses the posterior aspect of the joint obliquely.

Fig. 119.



Longitudinal section of left knee joint, showing reflection of synovial membrane. 1, cancellous structure of lower part of femur; 2, tendon of extensor muscles of legs; 3, patella; 4, patella ligament; 5, cancellous structure of head of tibia; 6, bursa between patella ligament and head of tibia; 7, mass of fat projecting into cavity of joint below patella; 8, 13, synovial membrane, ascending between tendon of extensor muscles of leg and front of lower extremity of femur, continuous course of membrane being indicated by line passing around surfaces of bones; 9, alar ligament, the other having been removed with opposite section; 10, adipose ligament entire, section being made to its inner side; 11, anterior or external crucial ligament; 12, posterior ligament.

The *Synovial Membrane* (Fig. 119), like all other serous membranes, is a shut sac, but its reflections are somewhat complicated. Beginning, however, at the upper margin of the patella, we find it continued upward to the distance of about two inches

between the tendon of the extensor muscles and the anterior part of the lower extremity of the femur, spreading out upon each side beneath the large muscles, but prolonged considerably higher upon the inner than upon the outer side; it then covers the trochlea and condyles of the femur,* dips into the intercondyloid notch, surrounds the crucial ligaments, covers the posterior ligament, and is then reflected forward upon the articular surface of the tibia, incloses the interarticular cartilages, and descends behind the patella ligament nearly as far as the anterior tuberosity of the tibia; from this point it ascends behind the ligament and the patella, and, from the lower border of the latter, sends a triangular, flattened fold backward to the anterior extremity of the intercondyloid notch of the femur. This fold is called the *adipose ligament* (ligamentum mucosum), and varies in size in different individuals. Besides this, it forms several little fringelike prolongations upon each side of the patella, which lie loose and floating in the joint; these are sometimes, but improperly, called the *alar ligaments.*

The *Articular Adipose Tissue* forms a considerable mass behind the upper part of the patella ligament, which it renders prominent during extension of the leg. It is covered posteriorly and laterally by the synovial membrane, and is drawn during flexion by the adipose ligament into the space between the condyles of the femur and the upper surface of the head of the tibia. Its only use seems to be to fill up an interspace which would otherwise be unoccupied.

The motions of the knee joint are limited to flexion and extension.

The Peroneo-tibial Articulations.—These are two in number, a superior and an inferior, both diarthrodial.

The *Superior Peroneo-tibial Articulation* occurs between the upper extremity of the fibula and the back part of the external tuberosity of the tibia, these bones presenting two flat oval surfaces covered with cartilage, provided with a simple synovial membrane, and bound together by an *anterior* and a *posterior ligament.* The two ligaments are oblique in their direction, and attached to the adjacent parts of the two bones in front of and behind the articulation. The synovial membrane is sometimes only a prolongation of that of the knee joint, but ordinarily a separate sac.

The *Inferior Peroneo-tibial Articulation* is formed between the internal surface of the lower extremity of the fibula, which here presents a transversely oblong convex facet, and the external side of the extremity of the tibia, whose articular surface is correspondingly concave and continuous with the tarsal surface of the bone. The ligaments are: 1, an *anterior,*

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* It must be borne in mind that, strictly speaking, synovial membrane does not cover articular cartilages, but to facilitate the description it is here assumed to invest all the free surfaces within the joint.

which is of a pearly white color, thick and strong, and extends obliquely downward and outward from the tibia to the anterior surface of the head of the fibula; 2, a *posterior*, like the anterior in its direction, but broader and somewhat triangular in shape; 3, an *interosseous*, consisting of numerous short dense fasciculi, extending between the contiguous rough triangular surfaces of the bones immediately above the articulation. The synovial membrane is a prolongation of that of the ankle joint.

Between the superior and inferior articulations, the tibia and fibula are separated by a long narrow interval occupied by a strong interosseous aponeurosis. This membrane assists in keeping the two bones together, but is of more special service in increasing the surface for muscular attachments. It is perforated above and below for the passage of the tibial and peroneal vessels.

The motion between these two bones is simply a little antero-posterior gliding, so slight as to be scarcely discoverable.

The Tibio-tarsal Articulation or Ankle Joint.—The Ankle Joint is an angular ginglymus formed between the tibia and fibula on the one hand, and the astragalus on the other. The superior articular surface is transversely oval, concave, terminated at its extremities by the internal and external malleolar processes, traversed about its middle by a broad, slightly elevated, rounded, antero-posterior ridge, and bordered before and behind by the corresponding peroneo-tibial ligaments. The surface of the astragalus is quadrangular, elongated and convex antero-posteriorly, and slightly concave from side to side; it is, in fact, a true trochlea or pulley, the vertical sides of which are also articular where they correspond to the two malleoli. The surfaces are covered with cartilage and synovial membrane, and are bound together by three ligaments, namely, two lateral, and an anterior.

The *Internal Lateral Ligament* is a very strong, flat bundle of fibres, which originates by a narrow extremity from the lower border of the internal malleolus, and spreads out to be inserted into the inner side of the astragalus, the calcaneum, and the scaphoid. The *External Lateral Ligament* consists of three separate bundles, which diverge from their origin upon the fibular malleolus; the *anterior*, very short, to be inserted into the astragalus in front of its lateral facet; the *middle*, long and rounded, into the external side of the calcaneum; and the *posterior*, the strongest of the three, into the posterior border of the astragalus, just above the groove for the tendon of the long flexor muscle of the great toe.

The *Anterior* or *Tibio-tarsal Ligament* is a broad, thin, ligamentous membrane, extending from the anterior margin of the articular surface of the tibia to the corresponding part of the pulleylike surface of the astragalus.

The synovial membrane covers the superior and lateral surfaces of the

astragalus, the articular faces of the anterior and lateral ligaments, the concave surface formed by the tibia and fibula, and sends a prolongation upward to the inferior tibio-peroneal articulation. It is supported posteriorly, where there is no distinct ligament, by a few scattered aponeurotic fibres and areolar tissue.

The motions of the ankle joint are flexion and extension with slight lateral rocking.

The Tarsal Articulations.—The Bones of the Tarsus are articulated with one another in a very intricate yet most beautiful manner, forming by their union a solid elastic arch for the reception of the weight of the body. They are arranged into two sets, the first composed of the astragalus and calcaneum, and the second, of the cuboid, scaphoid, and the three cuneiform bones. The articulations comprise, therefore: 1, the articulations of the component bones of each set; and, 2, the articulation of the two sets together.

Articulation of the Bones of the First Set.—The Astragalo-calcaneal Articulation is a double diarthrosis, the two bones presenting each two smooth facets, an anterior and a posterior, separated by a deep groove, and provided with articular cartilages and synovial membranes. The principal means of union is a strong *interosseous ligament*, which consists of numerous short, thick, vertical, and oblique fasciculi, and fills up nearly the whole of the groove between the two articulations. Besides this, there is a *posterior* and an *external ligament;* the former is short and narrow, and connects the posterior border of the astragalus with the upper surface of the calcaneum; the latter is quite small, and extends from the under surface of the astragalus to the external side of the calcaneum.

Articulations of the Bones of the Second Set.—The Scaphoid Bone articulates with the three cuneiform by its anterior convex surface, which is divided into three triangular facets, covered with cartilage and furnished with one common synovial sac. The ligaments are two in number, a *dorsal* and a *plantar*, for each cuneiform bone; the former strong and well defined, the latter irregular and indistinct.

The Cuneiform Bones are articulated with each other by their lateral surfaces, which are smooth and provided with cartilage behind, but rough in front for the attachment of *interosseous ligaments.* They have also *dorsal ligaments*, which are strong transverse bands extending between the upper surfaces of the bones; and *plantar ligaments*, consisting of a few scattered fibres, which are really a part of the strong interosseous bundles.

The External Cuneiform and Cuboid are joined together very much like the preceding, *dorsal* and *interosseous ligaments* forming the bond of union.

The Scaphoid and Cuboid Bones are also connected together by *dorsal*, strong *interosseous*, and *plantar ligaments*, and sometimes, but not always, present a small diarthrosis with the usual articular cartilage and synovial membrane.

Articulations of the First and Second Set with one Another.—These are two in number, the Astragalo-scaphoid and Calcaneo-cuboid.

1. The *Astragalo-scaphoid Articulation* is a true ball-and-socket joint, the head of the astragalus being received into a corresponding cavity, formed above by the posterior surface of the scaphoid bone, and below by the anterior facet of the calcaneum and the calcaneo-scaphoid ligament. The only ligament proper to the articulation is a broad membranous band, called the *astragalo-scaphoid*, situated upon the dorsum of the foot, and extending from the anterior margin of the astragalus to the superior surface of the scaphoid bone. The *calcaneo-scaphoid ligament*, which completes the articular cavity below, is stretched, as its name indicates, between the scaphoid bone and the calcaneum, being attached to the lower border of the former and the process upon the inner side of the latter; it is remarkably strong, triangular in shape, flattened from above downward, in contact above with the synovial membrane of the joint, and below with the tendon of the posterior tibial muscle. Taking into consideration its use in binding the bones together, supporting the head of the astragalus, and through it the whole weight of the body, and in giving to the arch of the foot that elasticity for which it is remarkable, and which is so absolutely necessary to locomotion, it is one of the most important and interesting ligaments in the body.

Another ligament, called the *superior calcaneo-scaphoid*, is also considered as assisting in keeping the head of the astragalus in its place. It is situated upon the dorsum of the foot, deep in the fossa upon the outer side of the astragalus, and extends from the inner side of the calcaneum to the external border of the scaphoid.

2. The *Calcaneo-cuboid Articulation* is diarthrodial by mutual reception, the articular surface of the calcaneum being concave from above downward and convex transversely, and that of the cuboid the reverse. The opposed surfaces are provided with articular cartilage and a synovial membrane, and are bound together by a superior, an inferior, and an internal ligament. The first of these, the *superior calcaneo-cuboid ligament*, is broad and thin, and extends between the adjacent margins of the bones above the articulation. The *internal*, short, narrow, and quadrangular, is situated in the fossa upon the outer side of the astragalus, where it is partly united with the superior calcaneo-scaphoid ligament. The *inferior* is the longest and probably the strongest of the tarsal ligaments, and may be divided into two parts, a superficial and a deep seated. The former arises from the middle of the under surface of the calcaneum,

passes horizontally forward, and is inserted into the posterior margin of the groove of the cuboid, and, by a prolongation of some of its fibres, into the bases of the third and fourth metatarsal bones. The latter, separated from the other by areolar and adipose tissue, is broad and strong, and extends from the anterior inferior surface of the calcaneum to the adjacent part of the cuboid bone behind the groove.

These two articulations (the astragalo-scaphoid and calcaneo-cuboid) are directly upon a line with each other, rendering the partial amputation of the foot in this situation quite easy.

The motions of which these several articulations are susceptible are all of the gliding character and limited in extent.

The Tarso-metarsal Articulations.—The anterior extremity of the tarsus is articulated by diarthrosis to the bases of the five metatarsal bones; but the line of union is very irregular, owing to the projection forward of the first and third cuneiform bones, which form with the second a deep mortiselike notch for the reception of the base of the second metatarsal bone.

The base of the first metatarsal bone is in contact with the internal cuneiform; that of the second with the middle, and, laterally, with the internal and external cuneiform bones; the third with the external cuneiform; and the last two with the cuboid bone. The ligaments are of three kinds, namely—dorsal, plantar, and interosseous.

The *Dorsal Ligaments* are flat and thin, and extend from the anterior margin of the tarsus to the adjacent part of the metatarsus. They are seven in number, each metatarsal bone receiving one, except the second which has three, namely, one from the cuneiform bone upon which it rests, and one from each of the two others between which it is placed.

The *Plantar Ligaments* are divided into two sets, the *straight* and the *oblique*. The former are five in number, and extend directly from the bones constituting the anterior extremity of the tarsus to the bases of the corresponding metatarsal bones; as a general rule, they are less strong than the dorsal, except the first, which is large and well defined. The *oblique* set numbers only three, the first extending from the internal cuneiform to the second metatarsal bone, the second from the first cuneiform to the third metatarsal, and the third from the external cuneiform to the fifth metatarsal.

The *Interosseous Ligaments* are placed deep between the bones, and consist of numerous short, strong bands surrounding the articular facets, and extending between the contiguous rough surfaces.

The Metatarsal, Metatarso-phalangeal, and Phalangeal Articulations.—*The Metatarsal Articulations.*—The Metatarsal Bones are bound

together both at their tarsal and phalangeal extremities. In the former situation, all of them, except the first, present lateral articular facets, which are covered with cartilage, and provided with prolongations of synovial membrane from the tarso-metatarsal articulations. They are united by dorsal and plantar transverse bands and by interosseous fasciculi extending between the rough surfaces of the contiguous bones. The phalangeal extremities of the bones are bound together by the *transverse ligament of the metatarsus*, which is situated upon the plantar surface of the bones and unites them loosely together. Between the heads of the bones are prolongations of synovial membrane, but no articular facets.

The Metatarso-phalangeal and the Phalangeal Articulations.—These do not differ materially from the corresponding joints of the hand, and it is not, therefore, necessary to repeat the description.

PART III.

DISSECTIONS.

INTRODUCTION.

It is taken for granted that the student, who is about to commence the dissection of the human body, has already obtained a practical acquaintance with the several tissues of which it is composed, at least to the extent of being able to recognize them readily upon sight. To acquire this sort of information it is only necessary to procure suitable specimens of fresh meat from the butcher, when, with the assistance of some such brief outline of general anatomy as has been attempted in the first part of this book, the distinctive features of the individual tissues may soon be learned. But in addition to this it is equally requisite that he should have an accurate knowledge of the situation, relations, and special markings of the bones, for these constitute the landmarks in the study of the soft parts, and unless the student is familiar with them in advance, his dissections will prove of comparatively little benefit.

These preliminary studies, however, having been completed, the student should provide himself with an apron and a case of good dissecting instruments; and, since the supply of anatomical material is seldom abundant enough to justify the dissection of only a single class of structures at a time and the rejection of the rest, it is necessary to make use of means to preserve the subject from putrefaction, so that the work may be carried on deliberately with an eye to all the tissues and organs as they present themselves. This may be accomplished by injecting the arteries with some antiseptic fluid, such as common salt, arsenic, sulphate of alumina, creasote, etc.; but of all these and numerous other substances that have been employed, preference is generally given to hyposulphite of soda and to chloride of zinc. The usual mode of preparing and using the latter is to saturate commercial hydrochloric acid with metallic zinc, and to a pint of the neutral mixture thus produced add a gallon of water and inject the same through one of the common carotid arteries. After a few minutes this may be followed by sufficient hot tallow or plaster of Paris to fill the larger arteries and thus render them more easy of dissection. The chloride of zinc is objectionable on account of its destruction of the natural color of many parts, reducing them all to a dull white or grayish hue; but its powerful antiseptic and disinfectant properties more than counterbalance this undesirable effect. The hyposulphite of soda, although not so power-

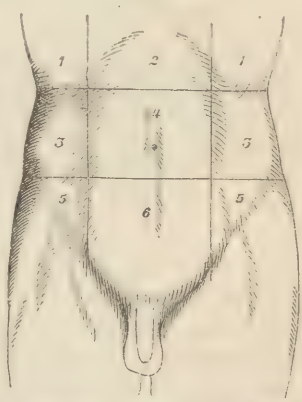
ful a preventive of putrefaction as chloride of zinc, has greatly the advantage over the latter in not altering or destroying the natural color of the tissues. It is used by making a saturated solution in water, of which a gallon or more may be thrown into the arterial system. Where the object is to study the smaller arteries, or to make a dried preparation, the common cold injection, consisting of two parts of white-lead ground in oil to one of Venice turpentine or rosin varnish, will be found to answer a very good purpose. It is also necessary to adopt some plan of operations by which the greatest economy of material and labor may be combined, and the greatest information derived from a single subject; for, as just intimated, it is not often possible to study anatomy systematically, that is, to take up one class of structures at a time, and devote an entire subject to its examination. Hence it becomes necessary to study the body by regions, and to examine every structure as it is met with, commencing with the most convenient parts, and with those organs which soonest decay. The plan which the author has pursued for many years, and which is generally followed in the schools of medicine in this country, is the one here presented.

Lastly, if the student desires to overcome those natural prejudices against dissecting which all feel in a greater or less degree, and to cultivate a genuine love for the study of anatomy, he must never forget the absolute necessity of scrupulous cleanliness, cleanliness not only from ordinary dirt, but from everything that may mar the beauty of the part exposed. It is well known that students generally do not take that interest in practical anatomy that the importance of the study requires, and this distaste is produced in no way so often as by a want of neatness in the dissecting room. Dissecting is filthy and repulsive only when made so by those engaged in it.

THE ABDOMEN.

THE Abdomen comprises all that part of the trunk which lodges the digestive organs, and should be examined progressively from without inward, commencing with its anterior and lateral walls. For convenience of reference and study, it is considered as divided into nine different regions or compartments, which may be marked off externally in the following manner: Draw a line from the lower margin of the cartilage of the ninth or tenth rib on one side to the corresponding point on the opposite side, and another between the highest points of the crests of the iliac bones; then intersect these by a vertical line on each side from midway between the anterior superior spinous process of the ilium and the spinous process of the pubis to the margin of the thorax, where it will usually rest over the cartilage of the eighth rib. The names of the regions thus defined are, commencing with the superior middle, the *epigastric*, below this the *umbilical*, and next the *hypogastric;* upon the sides, commencing above, the *right* and *left hypochondriac*, the *right* and *left lumbar*, and the *right* and *left iliac*.

Fig. 120.



Abdominal regions. 1, 1, right and left hypochondriac regions; 2, epigastric region; 3, 3, right and left lumbar regions; 4, umbilical region; 5, 5, right and left iliac regions; 6, hypogastric region.

The anterior and lateral walls of the abdomen extend from the lower margin of the thorax to the crests of the iliac and pubic bones, and on each side nearly as far back as the lumbar vertebræ. They consist entirely of soft structures, and should be dissected as follows:

*Dissection.**—Let the subject rest on its back with a block under the loins to render the parts tense, and, if this is not sufficient for the purpose, inflate the abdominal cavity with a blowpipe, introduced through an oblique opening made

* In the directions for dissecting it is assumed that the student can use the scalpel only in the right hand, as very few are ambidextrous.

with a narrow-bladed knife, immediately below the point of the ensiform cartilage. Next, divide the skin by a median incision carried from over the lower third of the sternum to the pubic symphysis; and from the extremities of this make two lateral incisions, a superior, extending obliquely across the thorax to the extremity of the twelfth rib, and an inferior, extending to the anterior superior spinous process of the ilium, and thence along the crest of this bone as far as its posterior third. If the subject is a male, the lower incision on one side may be made from a point midway between the umbilicus and pubic symphysis to the before-mentioned spinous process, and thence along the iliac crest, thus marking off a triangular space below containing the parts concerned in inguinal hernia, which should be left untouched until after the remainder of the anterior and lateral walls has been completely dissected. Commencing now at one or other of the angles formed by the incisions, the skin alone should be removed in one entire flap and allowed to hang from the side posteriorly, care being taken to cut close to its under surface if the subject is much emaciated, to avoid removing any of the subjacent areolar tissue, which is the first structure brought into view.

The **Subcutaneous Areolar Tissue**, which is spread over the whole surface of the body, is here, more than elsewhere, subject to a deposition of fat, which in corpulent subjects, especially females, often forms a layer an inch or more in thickness. In emaciated persons, this tissue is thin and delicate, and constitutes only a bond of union between the skin and the subjacent muscles. A small artery of no practical importance, called the *superficial epigastric*, with its accompanying vein, ramifies in its substance over the iliac region on each side, obliquely upward and inward.

The under surface of this tissue is somewhat condensed to form the anterior layer of the sheath of the abdominal muscles. This is frequently referred to as a separate structure under the name of the *superficial fascia*, but when the adipose deposit is wanting, it is often impossible to make the distinction. Like the areolar layer, of which it is a part, this fascia is not confined to the abdomen, but is continued over the thorax, back, thighs, etc., closely investing the structures beneath, but varying in its thickness and density, according to the degree of pressure which it is required to sustain. In dissecting the flap reserved to study the anatomy of inguinal hernia, this fascia will claim particular attention.

Dissection.—To remove the subcutaneous areolar tissue and superficial fascia, commence next at the cut edge of the skin upon the thorax, near the median line, and by repeated strokes of the scalpel turn it downward and outward in one continuous layer. In performing this dissection, it should be known beforehand that the fibres of the external oblique muscle, which is the structure about to be brought into view, are directed downward and inward, and, to make a clean dissection, it is absolutely necessary to follow the same direction with the knife. In fact, the beginner should, at the outset, make it an inviolable rule always to dissect a muscle in the direction of its fibres, for, however skilful he may be in the use of the knife, he can never make a neat dissection in any other way. In removing the fascia over the lower part of the sternum, great care is necessary to avoid taking up, at the same time, the tendon of the external oblique muscle, which here covers the superior extremity of the straight muscle in the form of a thin membranous expansion. The same caution is necessary along the whole line of union between the muscular and tendinous fibres, and to avoid this accident it is best always to keep the dissection over the latter considerably in advance.

If the fascia has been exposed only throughout one side of the abdomen, it may be turned down from the other along with the skin. In performing this dissection, several small vessels, and some cutaneous branches of the lumbar and lower intercostal nerves, will be unavoidably divided.

The Muscles of the anterior and lateral abdominal walls are in pairs, and for the most part spread out in layers with thin but strong membranous tendons. Those forming the lateral walls are three in number, namely: the external oblique, internal oblique, and transverse muscles. They are placed one above another in the order here mentioned, but are separated by thin laminæ of condensed areolar tissue (intermuscular fasciæ or septa), and inclose by their tendons in front the anterior group, which consists of only two, the straight and pyramidal muscles.

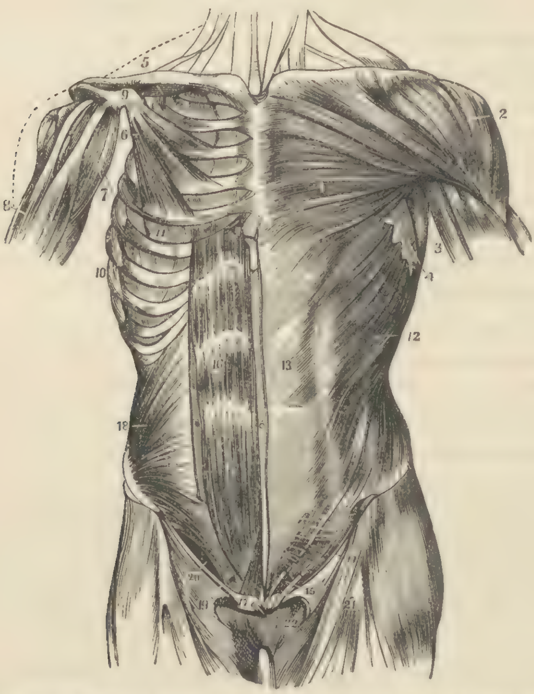
The **External Oblique Muscle** (Fig. 121, $_{12}$) derives its name partly from its situation, and partly from the obliquity of its fibres. It is broad, thin, and irregularly quadrilateral, and originates above from the external surfaces of the seven or eight inferior ribs, a short distance from their cartilages, by as many fleshy slips, of which the five superior indigitate with the great serrated muscle[4], a lateral muscle of the thorax, and the three inferior with the latissimus[3], a muscle of the back. From these points the fibres descend forward and inward with different degrees of obliquity, the posterior, nearly vertical, to be inserted by short, white, tendinous fibres into the anterior half or two-thirds of the outer lip of the crest of the ilium; and the middle and anterior by means of a strong, white, fibrous membrane[13], which is the tendon of the muscle, into the anterior superior spinous process of the ilium, the spinous process and crest of the pubis, and into the tendon of the corresponding muscle of the opposite side along the middle line of the abdomen from the pubic symphysis to the ensiform cartilage. At this insertion along the median line, the aponeurosis or tendons of all the three lateral abdominal muscles meet and form a white line called the *linea alba*, which extends the whole length of the anterior wall of the abdomen from the sternum to the pelvis, being interrupted a little below its middle by the umbilicus or navel.

Where the aponeurosis of the muscle is stretched from the anterior superior spinous process of the ilium to the spine of the pubis, it is thickened and turned in upon itself, so as to form a well-defined margin, known as *Poupart's ligament* or the *crural arch*[14]. A continuation of the same tendinous fibres is inserted for about an inch into the anterior extremity of the ilio-pectineal line, forming what is called *Gimbernat's ligament;* but this cannot be seen until the muscle is turned down.

Immediately above and a very little external to the spinous process of the pubis, the aponeurosis presents an oval-shaped opening, called the *External Abdominal* or *Inguinal Ring*[15], which gives passage in the male

to the spermatic cord, and in the female to the round ligament of the uterus. The opening is formed by a separation of the tendinous fibres, which, it will be seen, commences some distance above, but is covered in as far as the opening by strong intersecting fibres which arise from the crural arch, a short distance below the anterior superior spine of the

Fig. 121.



Muscles of anterior aspect of trunk; on left side superficial layer, on right side deeper layer. 1, great pectoral muscle; 2, deltoid muscle; 3, latissimus muscle, anterior border; 4, indigitations of great serrated muscle; 5, right subclavian muscle; 6, small pectoral muscle; 7, coraco-brachial muscle; 8, upper part of biceps, showing two heads; 9, coracoid process of scapula; 10, great serrated muscle of right side; 11, external intercostal muscle of fifth intercostal space; 12, external oblique muscle; 13, its tendon or aponeurosis; on left of this, semilunar line, on right middle white line (linea alba); 14, Poupart's ligament or crural arch; 15, external inguinal or abdominal ring; crescentic opening to right of 15 is saphenous opening in femoral aponeurosis; 16, straight abdominal muscle of right side, exposed by removal of anterior segment of sheath formed by tendons of lateral broad muscles; 17, pyramidal muscle; 18, internal oblique muscle; 19, conjoined tendon of internal oblique and transverse muscles; 20, arch formed by lower border of internal oblique and transverse muscles, from beneath which the spermatic cord has been removed.

ilium, and curve upward and inward toward the middle white line of the abdomen. The lateral margins of the ring are often called its pillars or *columns*, of which the inner or superior is attached to the pubic crest and symphysis, interlacing with the fibres of the opposite muscle, while the outer or inferior is formed principally by the internal extremity of the

crural arch. From these margins, a thin membranous expansion, named the *spermatic* or *intercolumnar fascia,* is prolonged downward upon the spermatic cord.

Relations.—The external oblique muscle is covered throughout by the subcutaneous areolar tissue, and is slightly overlapped behind by the anterior margin of the latissimus muscle. It lies upon the anterior extremities and cartilages of the seven or eight inferior ribs, and the corresponding intercostal muscles, and upon the whole extent of the internal oblique muscle, from which it is separated only by a thin septum of condensed areolar tissue.

Besides the middle white line formed by the intersection of the opposite muscles, two others, much less distinct, may be seen in this view, extending on each side from the inferior margin of the thorax, a little distance outside of the ensiform cartilage, toward the inner extremity of the crural arch. They are formed by the union of the fleshy and aponeurotic portions of the muscles below, and from their slightly curved directions are called the *semilunar lines.*

Dissection.—The external oblique muscle should now be removed, together with the intermuscular fascia that separates it from the internal oblique, and in order to dissect in the course of this latter muscle, whose fibres run obliquely from below upward and forward, it is necessary to proceed differently on the two sides. On the right side, the tendon of the external oblique should be divided by an incision extending from the spine of the ilium directly across to the semilunar line and turned upward, cutting it from the crest of the ilium and along the semilunar line* in the progress of the dissection, taking care to carry along with it the subjacent fascia, which is here very thin. When the dissection has reached the margin of the thorax, the muscle may be divided across, or removed entirely by detaching its different heads. The little flap of tendon left below may then be turned down and allowed to remain. On the left side, the muscle should be cut across the direction of its fibres upon the thorax, and the removal commenced posteriorly, turning the whole muscle forward as far as the semilunar line, where it may be cut off. The small fleshy flap left upon the thorax may be subsequently removed by cutting loose its attachment to the ribs.

The **Internal Oblique Muscle** (Fig. 121, $_{18}$), broad and thin like the preceding, originates from the lumbar aponeurosis, which cannot be seen in this dissection, from the anterior two-thirds of the middle lip of the iliac crest, and from the external third of Poupart's ligament. It is inserted: 1, by tendinous and fleshy fibres into the anterior two-thirds of the lower margin of the thorax; 2, through a strong aponeurosis into the whole length of the middle white line (linea alba); and, 3, by means of a flattened tendon common to it and the subjacent muscle, and hence called the conjoined tendon of the internal oblique and transverse, into the crest of the pubis, and into the ilio-pectineal line directly behind the external abdominal ring. It will thus be seen that the fibres of the muscle diverge

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* The object in dividing the muscle along the semilunar line is to leave for the present the sheath of the straight muscle untouched.

from their origin; the posterior passing almost vertically upward, and the inferior downward and inward. The latter form a curved margin or arch[20], beneath which the spermatic cord passes obliquely toward the external ring, where it is placed directly in front of the conjoined tendon.

The aponeurosis of the internal oblique muscle cannot be examined until the straight muscle is dissected, when it will be found to divide into two laminæ, one of which lies in front of this muscle its whole length, while the other is situated behind, and is deficient in the lower fourth of the abdomen.

Connected with the inferior margin of the internal oblique muscle, and partly seen in this dissection, is the *cremaster muscle*, to be described hereafter. It consists of a few pale, scattered, fleshy fibres, which have their origin from the crural arch immediately below that of the internal oblique muscle, and, passing off upon the spermatic cord, are reflected upon it and around the testicle, in the form of loops, whose inner extremities are inserted into the crest of the pubis.

Relations.—The internal oblique muscle is covered by the external oblique, lies upon the transverse, and is slightly overlapped behind by the latissimus muscle. Its most important relations, however, are those with the external inguinal ring, the inguinal canal, and the spermatic cord, which will be hereafter described in connection with the parts concerned in hernia.

Dissection.—To remove the internal oblique muscle of the right side, divide it transversely across from the outer extremity of the crural arch to the semilunar line, and turn the flap upward, taking care to remove with it the subjacent fascia, which is here very thin. As the dissection progresses, it will be necessary to cut the muscle along the semilunar line, iliac crest, and lumbar aponeurosis, and, finally, along the margin of the thorax. The student may have some difficulty in distinguishing the internal oblique from the transverse muscle at the point of division, as they are here closely connected; but if the branches of the circumflex iliac artery with their accompanying veins, which ramify between the two near the iliac spine, be taken as the guide, there will be no difficulty. That portion of the muscle below the incision is frequently so intimately blended with the transverse that it is of no practical importance to separate the two.

Upon the left side, the dissection may be commenced at the margin of the thorax near the superior termination of the semilunar line; from this point the muscle and subjacent fascia should be turned down, detaching them from the ribs and along the semilunar line in the course of the fibres underneath.

In removing the internal oblique muscle, several branches of the lumbar nerves are necessarily divided. The most important of these is one that lies between it and the transverse muscle, near the spinous process of the ilium, sending filaments to the outer part of the thigh and scrotum, and hence called the *ilio-scrotal* or *superior musculo-cutaneous nerve.*

The **Transverse Muscle** (transversalis) is the most internal of the broad lateral muscles of the abdomen, and of a much less firm consistence and bright red color than the two preceding. It originates from the margin of the thorax, the lumbar aponeurosis, the anterior two-thirds of the inner lip of the crest of the ilium, and the outer third of Poupart's liga-

ment; from these points the fibres pass for the most part transversely, and terminate in a broad aponeurosis, which is inserted into the ensiform cartilage, linea alba, and crest of the pubis. The lowermost fibres curve downward, and are inserted by means of the conjoined tendon into the crest of the pubis and ilio-pectineal line. The aponeurosis, in the upper three-fourths of its extent, passes behind the straight muscle in connection with the posterior layer of the internal oblique, but in the lower fourth it lies in front of the same.

Relations.—The transverse muscle lies upon the subperitoneal or transverse fascia, and is covered by the internal oblique, a thin fascia intervening. At the inferior part of the abdomen, where the muscle passes from the crural arch to the crest of the pubis, it crosses the track of the inguinal canal obliquely.

Dissection.—The transverse muscle should be left in position until the straight and pyramidal muscles have been dissected. To expose these, the sheath formed by the tendons of the preceding muscles should be divided a short distance from the linea alba, the incision extending from the margin of the thorax to the pubis, and the two flaps turned aside. Except at certain transverse tendinous lines, to be presently mentioned, the sheath is not very closely connected with the muscle. The same mode of dissecting is applicable to both sides.

The **Straight Abdominal Muscle** (rectus abdominis) (Fig. 121, $_{16}$), so called from the vertical direction of its fibres, extends in front of the abdomen from the pubis to the thorax. It is long and flat, broader above than below, and occupies the partial sheath formed by the tendons of the lateral broad muscles. It originates from the crest of the pubis by a broad flat tendon, ascends nearly parallel with its fellow of the opposite side, and is inserted fleshy into the costo-xiphoid ligament, and into the cartilages of the fifth and sixth ribs, and sometimes, also, into those of the fourth and seventh. The fleshy fibres do not extend the whole length of the muscle, but are divided into sections, of which there are generally four or five. These sections are connected with each other by narrow tendons, called *tendinous intersections*, which run a zigzag course across the muscle, but do not always involve its whole thickness or breadth. One of these transverse intersections or lines is usually found at the umbilicus, another opposite the extremity of the ensiform cartilage, and a third between these two. If more than three exist, the others generally occur below the umbilicus.

Relations.—The superior extremity of the muscle rests upon the cartilages of the fifth, sixth, seventh, eighth, and ninth ribs, and the corresponding intercostal muscles: below the margin of the thorax, as far down as midway between the umbilicus and pubis, it is inclosed by the aponeurotic laminæ already mentioned, and in the rest of its extent it lies between these laminæ and the peritoneum, a thin layer of loose areolar tissue intervening. Its tendon is crossed obliquely in front by

the pyramidal muscle, and is continuous at its outer margin with the transverse fascia.

The muscle is separated from its fellow by the linea alba, which is much broader above the umbilicus than below it.

The **Pyramidal Muscle** (pyramidalis) (Fig. 121, $_{17}$) is situated in front of the lower extremity of the preceding, and, as its name indicates, is somewhat pyramidal in shape, its base presenting downward. It originates broad and fleshy from the crest of the pubis in front of the tendon of the straight muscle, ascends, and is inserted into the white line, midway between the umbilicus and pubic symphysis. The external fibres of the muscle are very oblique, but the internal are nearly vertical. The muscle varies in size in different individuals, and is not unfrequently absent upon one or both sides.

Dissection.—The straight muscle may now be divided near its middle, and the two sections turned back and removed from the subject. In dissecting off the lower portion, the abrupt transversely lunated margin of the posterior layer of the aponeurotic sheath, midway between the umbilicus and pubis, will be distinctly seen, and also the epigastric artery, as it ascends obliquely inward, behind the muscle, and within the sheath, giving branches to all the adjacent parts. Two veins, one on each side, accompany the artery.

Action of the Abdominal Muscles.—The use of the abdominal muscles is threefold: 1. They form a support and protection to the contents of the abdomen. 2. By compressing the organs within, they assist in defecation, micturition, parturition, and the other mechanical functions which it is the office of some of these organs to perform. 3. They flex the upper part of the body upon the pelvis, and *vice versâ;* rotate it to one side or the other; and depress the ribs, thus aiding in respiration, etc., according to the particular muscles brought into action. The internal and external oblique muscles depress the ribs, flex the upper part of the trunk on the pelvis or conversely, compress the abdominal viscera, and rotate the body to one side or the other. The transverse are principally employed in compressing the cavity of the abdomen, but, through their attachment to the ribs, they also assist in respiration. The straight muscles act most powerfully in flexion of the trunk, in which they are assisted by the pyramidal, whose special office is to make tense the aponeurosis in the median line.

Dissection.—The cavity of the abdomen should now be laid open by dividing the remaining structures, from the point of the sternum to the pubic symphysis, intersecting this incision by a transverse one, about midway between the thorax and pelvis. Before proceeding, however, to an examination of the contents of this cavity, the triangular flap, that has been reserved for the study of the parts concerned in inguinal hernia, should be carefully dissected.

ANATOMY OF THE INGUINAL REGION.

Protrusion of the abdominal viscera is most liable to take place in the inguinal region, or, as it is commonly called, the groin. This region forms the lowest part of the abdomen upon either side of the median line, and, for the purpose of dissection, may be marked off by a line drawn from the anterior superior spinous process of the ilium to a point midway between the umbilicus and symphysis pubis, and thence vertically downward to the latter, constituting two sides of a triangle, of which the third is formed by the flexure of the thigh.

Dissection.—The parts having been made tense by means of hooks, commence at the superior internal angle of the triangular flap, and dissect off the skin, turning it downward and outward. Next, evert the subcutaneous areolar tissue and superficial fascia as far as Poupart's ligament, dissecting it clean from the tendon of the external oblique, and taking care at the same time not to remove the spermatic fascia where it passes from the margins of the external ring over upon the spermatic cord. This having been done, and the adhesion of the deep surface of the fascia to the crural arch noted, dissect off the tendon of the external oblique, and the fleshy fibres of the internal oblique muscle, as they arch over the inguinal canal to reach the conjoined tendon, will be brought into view; also, the origin of the cremaster muscle, and, lying close to Poupart's ligament, the scrotal branch of the ilio-scrotal nerve on its way to the external ring. Next, turn down the fleshy and aponeurotic flap formed by the internal oblique and transverse muscles, being careful to cut close to the under surface of the latter muscle, in order to avoid wounding the subjacent fibrous membrane, called the transverse fascia. In the next place, dissect down the transverse fascia and the lower extremity of the straight muscle, to the outer margin of which it is attached, together with the epigastric artery from the peritoneum. Lastly, the peritoneum should be divided so as to expose its internal surface.

The dissection having been completed, the student should now proceed to examine the several structures, commencing with the common integument or skin.

The **Skin** of the groin is soft and thin, covered with scattered hairs, and abounding in sebaceous follicles. Beneath it may be felt the lymphatic glands, which are quite numerous in the lower part of this region and the crural arch.

The **Superficial Fascia**, as before mentioned, extends over the whole surface of the abdomen, around to the spine, over upon the thorax, down upon the thighs, and into the scrotum. It may be separated into two distinct layers, of which the external, known as the subcutaneous areolar tissue, is loose and open in its texture, and always more or less loaded with fat; the internal is thin, but close and firm, forming the external lamina of the sheath of the external oblique muscle, and, in passing over upon the anterior surface of the thigh, becomes closely adherent to the crural arch. Several small vessels ramify through the substance of the superficial fascia, of which the principal is the superficial epigastric artery with its two accompanying veins: the former, a branch of the femoral artery, ascends from the front of the upper part of the thigh to be dis-

tributed to the skin of the abdomen, but is too small to claim particular notice.

The *superficial inguinal lymphatic* glands are also contained within this fascia, forming two separate groups, one above, and the other below the inner third of Poupart's ligament. The former receive the superficial lymphatic vessels of the penis and lower part of the abdomen, and are interesting as being the seat of syphilitic bubo.

The superficial fascia assists in strengthening the walls of the abdomen, and by its elasticity aids in their contraction after prolonged distention. It forms the second covering, from without, to hernial tumors that protrude externally to the abdominal muscles in this situation, in which case it is much more dense and strong than in its natural condition.

The **Tendon of the External Oblique Muscle** is situated beneath the superficial fascia, and is by far the strongest lamina of the abdominal walls in this region.

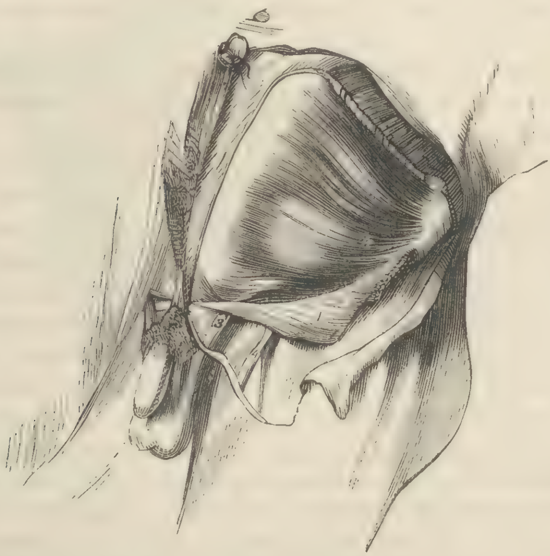
The outlet of the inguinal canal, called the *External Abdominal* or *Inguinal Ring* (Fig. 121, $_{15}$), is situated in this tendon almost immediately above the spine of the pubis, and directly in front of the insertion of the conjoined tendon of the internal oblique and transverse muscles. As before stated, it is formed by a separation of the fibres of the tendon commencing some distance above and externally, but the interval is closed by numerous curved fibres which pass upward and inward upon the surface of the aponeurosis. The margins of the separation are sometimes called the *columns* of the ring, and the intersecting fibres have hence been named the *intercolumnar fibres.* If carefully examined, these will be found prolonged from the margins of the ring in the form of a thin tubular sheath upon the spermatic cord, called the *spermatic* or *intercolumnar fascia.* In order to display the fascia to advantage, the handle of the scalpel should be pressed into the ring from behind in the direction of the scrotum, with the superficial fascia of which it will be seen to be continuous.

If the spermatic fascia be cut from the circumference of the ring, this opening will be found to be nearly oval, with its long axis in the direction of the tendinous separation above. Its size in the male adult is from a half to three-quarters of an inch in its longest direction, but it is subject to considerable variety.

The lower portion of the **Internal Oblique** and **Transverse Muscles,** brought into view by turning aside the preceding aponeurosis, consists of pale muscular fibres, which originate from the outer third of the crural arch, curve downward and inward, crossing the track of the spermatic cord obliquely from without, and are inserted into the crest of the pubis directly behind the external ring, by a flattened tendon called the *conjoined tendon.*

The *Spermatic Cord* (Fig. 122, 3) passes beneath the lower curved edge of the internal oblique and transverse muscles, and downward and inward along the inguinal canal, traversing the external inguinal ring to reach the scrotum. It has the appearance of a pale fleshy cylindrical mass, and between the thumb and forefinger it may be felt to consist of several structures, among which may be distinguished, by its firm cordlike feel, the seminal duct or deferential tube on its way from the testicle to the cavity of the pelvis. Upon its surface may be seen the scattered fibres of the cremaster muscle, which should now be examined.

Fig. 122.



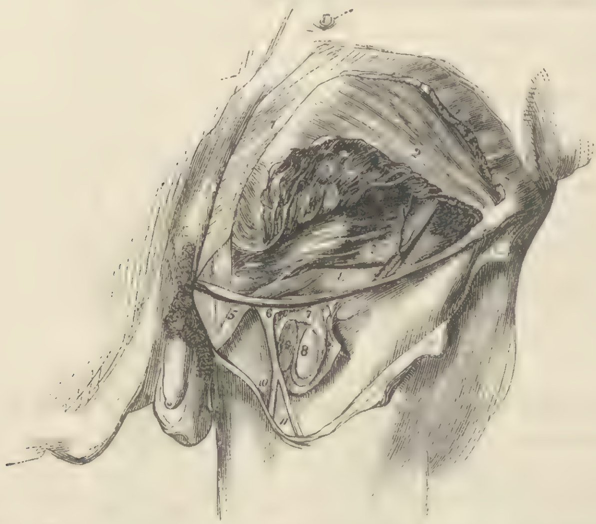
Aponeurosis of external oblique muscle having been divided and turned down, internal oblique is brought into view with spermatic cord escaping beneath its lower edge. 1, aponeurosis of external oblique; 2, internal oblique muscle; 3, spermatic cord; 4, saphenous vein.

The *cremaster muscle* is the second of the special investments of the cord, the spermatic or intercolumnar fascia forming the first. It consists of a few fasciculi of pale fleshy fibres, which originate from the crural arch immediately below and on the same plane with the lowermost fibres of the internal oblique muscle, and pass down upon the external and anterior surface of the cord beneath the spermatic fascia. As they descend into the scrotum, the fibres separate and form loops around the testicle and upon the front of the cord, and return to be inserted into the crest of the pubis near the symphysis. The muscle is not equally well developed in all persons; it is very indistinct in some, and in others it consists of numerous fasciculi nearly as red as those of the internal oblique

muscle. Its office is to support the testicle and draw it toward the external ring.*

If, before proceeding to an examination of the transverse fascia, the student will turn down the muscular layer just under consideration, and look at its posterior surface, he will observe that the lower margin of the transverse is somewhat higher than the margin of the internal oblique muscle, but that, like the latter, it arches obliquely across the spermatic

Fig. 123.



Lower part of external oblique having been removed (with exception of small slip including the crural arch), and lower portion of internal oblique raised, transverse muscle and fascia are here brought into view; femoral artery and vein seen to small extent, femoral aponeurosis (fascia lata) having been turned aside and sheath of vessels laid open. 1, external oblique muscle; 2, internal oblique; 2′, part of same turned up; 3, transverse muscle, upon which is seen branch of circumflex iliac artery with its companion veins; 4, transverse fascia; 5, spermatic cord covered with tubular or infundibuliform prolongation of transverse fascia; 6, upper angle of iliac part of femoral aponeurosis; 7, sheath of femoral vessels; 8, femoral artery; 9, femoral vein; 10, saphenous vein; 11, vein joining it.

cord from Poupart's ligament to the conjoined tendon. In some instances, however, this margin is even lower than that of the internal oblique, and the testicle, in descending into the scrotum, has been known to pass through it, thus leaving some of the fibres below the cord.

* The cremaster is usually considered as an appendage to the internal oblique muscle, and is described as originally formed from its lowermost fibres, which are said to be carried down before the testicle, as this organ descends from the cavity of the abdomen into the scrotum. To this explanation, however, there are numerous objections, of which two may be stated here: 1. This origin is opposed to all laws of organic development, being too mechanical and too much a matter of chance. 2. In the buffalo, the muscle is found to surround the testicle before its descent into the scrotum.

The **Transverse Fascia** (*fascia transversalis*) (Fig. 123, $_4$) is a fibrous membrane, but sometimes only a thin layer of condensed areolar tissue, situated in the lower part of the abdomen behind the transverse muscle. It may be described as extending from the posterior aspect of the crural arch, and the outer margin of the inferior extremity of the straight muscle, upward upon the anterior surface of the peritoneum, gradually becoming blended with the common areolar tissue, that connects this latter membrane and the transverse muscle throughout the upper part of the abdomen. At its attachment along the crural arch, it meets with the iliac fascia from the posterior wall of the abdomen, and with the pelvic fascia from behind the anterior wall of the pelvis; below the internal third of the arch it passes out upon the thigh in front of the femoral artery and vein, and forms here a part of a funnel-shaped process, which will be examined in connection with the anatomy of femoral hernia. The outer portion of the transverse fascia, which is connected to the external half of the crural arch, is stronger and much more distinctly fibrous than the inner portion, and at the point where these two divisions meet, that is, midway between the spine of the pubis and the superior spine of the ilium, immediately above the crural arch, is the perforation known as the internal abdominal ring.

The **Internal Inguinal** or **Abdominal Ring** is not, as its name would seem to indicate, an abrupt well-defined opening through the transverse fascia, such an opening, for instance, as may be cut in a piece of paper, but its margins are prolonged upon the spermatic cord which occupies it in the form of a delicate sheath, called the infundibuliform process or *tubular fascia.* This sheath is continued down into the scrotum, often as far as the testicle itself, and may frequently be beautifully demonstrated by inflating it by a blowpipe inserted at the internal ring. The ring is properly the entrance of the inguinal canal, and, by pushing the peritoneum a little back, the spermatic vessels and seminal duct may be seen converging toward it, from the posterior and inferior part of the abdomen.

The internal ring is covered behind by the peritoneum, and protected in front by the lower fibres of the transverse and internal oblique muscles, which here originate from Poupart's ligament. Its most important relation, however, is with the *epigastric artery*, which branches from the external iliac a few lines behind the crural arch, and, in a general way, is directed obliquely upward and inward upon the posterior aspect of the transverse fascia, to the posterior surface of the straight muscle whose sheath it enters. In the first part of its course, it descends a little in order to reach the crural arch, and then ascends obliquely along the inner boundary of the internal inguinal ring, and so near it, that the deferential tube, as it enters the ring, seems to hook around the vessel. It is, there-

fore, placed behind the inguinal canal and between the two rings, but much nearer the internal, so that a portion of bowel or other organ pushed into the latter would have the vessel directly upon its inner side; whereas, if the protrusion occurred opposite the external ring, the artery would be some distance to the outer side. This relation should be carefully remembered, for if the artery were divided in an operation, serious hemorrhage would take place.

Besides the epigastric artery, with its two accompanying veins, the seminal duct, and the spermatic vessels, there may also be observed in this dissection a small fibrous cord upon the anterior surface of the peritoneum, passing up from the cavity of the pelvis behind the inguinal canal and between the two rings toward the unbilicus. This is the remains of the umbilical artery of the fœtus; and if the peritoneum is laid open and viewed from within, it will be found to form a fold upon the inner face of this membrane and two corresponding fossæ, of which the external is well marked, and being situated opposite the internal ring may act as a predisposing cause to hernia at this point, by detaining a portion of bowel or other organ within its concavity, during violent contraction of the abdominal walls.

Having now separately examined the several layers forming the abdominal parietes in the inguinal region, it will be well to study the relations which they bear, as a whole, to the inguinal canal.

The **Inguinal Canal** is the passage occupied by the spermatic cord between the internal and external rings. It measures in the adult from an inch and a quarter to two inches in length, and is directed obliquely downward, inward, and forward. Its boundaries may be stated as follows: *in front*, it is covered by the tendon of the external oblique muscle, from which, however, it is separated in the outer fourth of its extent by the lowest fibres of the internal oblique and transverse muscles, which originate from the adjacent part of the crural arch; *behind*, it is separated from the peritoneum in its outer three-fourths by the transverse fascia, and at its inner extremity by the conjoined tendon; *below*, it is closed by the union of the inverted margin of the crural arch with the transverse fascia; *above*, it is crossed obliquely, near its outer extremity, by the arched margin of the internal oblique and transverse muscles, and in the remainder of its extent is closed by the contact of the tendon of the external oblique with the anterior face of the internal oblique.

As before mentioned, the inguinal canal is occupied by the spermatic cord in the male, and the round ligament of the uterus in the female. The spermatic cord consists essentially of the seminal duct and the spermatic vessels (artery, vein, and lymphatics) and nerves, which, converging from within the abdomen, enter the internal ring, and there be-

come covered, first, by the tubular prolongation of the transverse fascia; then, as they pass the inferior margin of the internal oblique muscle, by the cremaster muscle; and lastly, emerging at the external ring, by the spermatic or intercolumnar fascia.

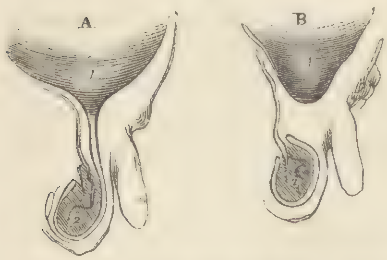
Having obtained an accurate knowledge of the anatomy of the inguinal region, the student should take into consideration the occurrence of hernia in this situation; but, as this involves some acquaintance with the history of the formation of the inguinal canal, or, in other words, of the descent of the testicle, a brief outline of this process is here introduced.

DESCENT OF THE TESTIS.

The Testes or Testicles are originally situated within the cavity of the abdomen just below the kidneys, and behind the peritoneum, but covered by it. Connected with each organ are: 1. A small artery, named the spermatic, which is derived from the aorta or from the renal artery in the immediate vicinity. 2. The spermatic vein, which is considerably larger than the artery, and terminates, the right in the cava vein, and the left in the left renal vein. 3. The seminal duct or deferential tube which descends from the back part of the organ along the posterior wall of the abdomen and pelvis behind the peritoneum to unite with the duct of the seminal vesicle near the neck of the bladder. 4. The gubernaculum, a small fibrous-looking band of a peculiar structure, attached by one extremity to the lower back part of the organ and extending thence through the abdominal walls over the body of the pubis, at the site of the future abdominal rings, into the scrotum. It is stated that by the contraction of the gubernaculum the testicle is drawn down into the scrotum. Be this as it may, about the sixth month of fœtal life the gland leaves its situation in the lumbar region, descends slowly toward the internal inguinal opening, which at this period is placed directly behind the external, there being no inguinal canal, properly so called, but a direct opening through the abdominal walls, and finally reaches the scrotum some time during the eighth or ninth month, or occasionally not until a short time after birth. Accompanying this change of position, there is necessarily some change in its connections, of which it is important to have a correct understanding. Thus the spermatic artery and vein, which were before comparatively short and horizontal, become elongated and nearly vertical; and the seminal duct, which previously descended directly into the back part of the pelvis, is now bent over, as it were, describing a curve along the internal lateral wall of this cavity. But the most interesting change is that connected with the peritoneum. As before mentioned, while the testicle is still within the abdomen, the lining membrane of this cavity covers the organ and is reflected from its sides posteriorly, as in the case

of the bowels or any of the proper abdominal viscera, so that, as the testis descends, it necessarily drags this membrane along with it, which, passing through the narrow inguinal openings, assumes somewhat the form of a finger of a glove, communicating above with the main peritoneal cavity. This will be better understood by a reference to the accompanying plate (Fig. 124), in which the tubular prolongation or *vaginal process*, as it is called, is well shown. It may be also farther stated that the position of this structure is anterior to the spermatic vessels. But in the course of a short time this narrow tube becomes obliterated from the external ring to within a short distance of the testicle, thus cutting off the communication and constituting that portion of the membrane investing the organ an independent serous sac known as the vaginal tunic of the testicle. If, however, a portion of bowel or omentum should escape from the abdominal cavity along with the testicle, as occurs in congenital hernia, the communication between the vaginal tunic and the peritoneum is maintained.

Fig. 124.



Plans intended to represent small part of peritoneum and vaginal tunic of testicle. A, serous investment of testis, is seen to be a prolongation from peritoneum; while in B, the two membranes are shown distinct from one another, the tubular communication being obliterated. 1, peritoneal cavity; 2, testicle.

In traversing the inguinal passage, the testicle carries before it: 1st, the transverse fascia; 2d, the cremaster muscle, which, as before stated, is supposed to be only the lower margin of the internal oblique muscle; and 3d, the intercolumnar or spermatic fascia. All of these structures become spread out upon the spermatic cord, the first as a tubular sheath, the second in the form of pale scattered fibres, and the third as a thin indistinct expansion of areolar tissue, hardly distinguishable from the superficial fascia of the abdomen.

Besides the changes which occur in the vaginal process of the peritoneum, by which this structure is converted into areolar tissue, changes also take place in the abdominal walls in the inguinal region, which are not well understood. Thus, as already stated, at the time of the descent of the testicle, the internal inguinal ring is said to be situated directly opposite the external, over the spine of the pubis, but, in the adult, this opening is found about an inch and a half removed in the direction of the spinous process of the ilium. The common explanation of this is, that in the development of the body, particularly of the bones of the pelvis, the transverse fascia of this region is drawn outward and upward, but why the tendon of the external oblique muscle, in which the external

opening is situated, should remain in its original situation, is not ascertained.

INGUINAL HERNIA.

From the preceding account of the anatomy of the inguinal region, the student will readily understand why protrusion of the abdominal organs is more liable to occur in this situation than elsewhere; for the two most resisting laminæ of the abdominal walls are here perforated for the passage of the testicle, and the accommodation of the spermatic cord; the internal oblique and transverse muscles are deficient, and, lastly, in the contraction of the abdominal walls, the pressure of the contained viscera is in a great measure concentrated upon this region.

The most common points of protrusion are the two rings, and the organs most frequently protruded are the small bowel, colon, and omentum. In whichever situation the rupture takes place, or whatever organ is involved, the peritoneum lining the wall of the abdomen is always carried before the protruding organ, and constitutes the proper hernial sac. In the study of hernia, this fact should be strictly borne in mind. The hernial sac is therefore only a continuation of the peritoneum of the abdomen, lining the interior of the tumor, and varying with the latter, in size and shape, in different cases.

Oblique Inguinal Hernia.—A protrusion, occurring at the internal abdominal ring, is denominated oblique inguinal hernia, to distinguish it from the direct form which takes place at the external ring. In the former variety, a portion of bowel or other organ enters the internal ring, and, taking the course of the inguinal canal, emerges at the external ring, and thence may descend into the scrotum. It follows the original track of the testicle, and lies, in the majority of cases, in front of the spermatic vessels. The coverings of a hernia of this kind, in which the protruding part has reached the scrotum, consist, therefore, of the same structures that surround the cord beyond the external ring. They are, commencing from without:

1. The skin.
2. The superficial fascia or subcutaneous areolar tissue.
3. The spermatic or intercolumnar fascia.
4. The cremaster muscle, whose fibres may or may not be spread out upon the anterior surface of the tumor.
5. The tubular prolongation of the transverse fascia.
6. The peritoneum or proper hernial sac.

Direct Inguinal Hernia.—In direct, or, as it is sometimes called, *ventro-inguinal hernia,* the protruding organ, instead of entering the internal ring, and descending along the inguinal canal, makes a direct passage

through the walls of the abdomen opposite the external ring, carrying before it the peritoneum and transverse fascia, and, in many instances also, the conjoined tendon, which protects this ring behind. Very frequently, however, the conjoined tendon is lacerated, in which case it does not form one of the envelopes of the tumor. In this variety of hernia, the spermatic cord is usually pushed to the outer side, but sometimes spreads out in front of the tumor—a fact which should always be borne in mind, when an operation upon the parts becomes necessary. Passing through the external ring, and descending toward the scrotum, the hernia is placed beneath the following structures:

1. The skin.
2. The superficial fascia.
3. The spermatic or intercolumnar fascia.
4. The conjoined tendon, when this structure is not ruptured.
5. The transverse fascia in an attenuated form.
6. The proper hernial sac.

Such are the nature and position of the structures which cover the two varieties of inguinal hernia. But the student must not for a moment suppose that, in every case, these envelopes can be as readily separated and distinguished from each other, as in the natural state of the parts; for, as might be inferred, the irritation or slow inflammation set up by the constant pressure from within, the handling of the tumor by the patient, the injuries which such swellings are constantly receiving, and the treatment employed, produce such changes, that often the most expert anatomist would be puzzled in an attempt to assign to each its particular name. The effect of these changes differs widely in different cases. Sometimes there is thickening, and, at other times, attenuation, and, not unfrequently, complete alteration of some of the tissues, so that, although one may have accurate knowledge of the anatomy of the parts in a healthy condition, this knowledge will be of but little advantage without an acquaintance also with these pathological changes.

In operations upon either the oblique or direct variety of inguinal hernia, the position of the epigastric artery should always be previously ascertained. As before stated, this vessel crosses the inguinal canal behind, near the internal ring, and in oblique hernia would therefore be placed directly upon the inner side of the point of protrusion, or, in other words, along the inner side of the neck of the hernial sac. But in the direct form the relation is different; for here, the protrusion taking place opposite the external ring, leaves the artery an inch or more to its outer side.

It is not always possible, however, to distinguish these two varieties, for, in cases of oblique hernia of long standing, the internal ring is found opposite the external, having become dragged down by the long-continued traction of the tumor, and, of course, the epigastric artery is similarly dis-

placed. If the operator, under the supposition that the protrusion was direct, divides the structure upward and inward, he would almost necessarily sever the vessel. The only means of distinguishing these old cases of oblique from direct hernia is, a correct history of each individual case from its commencement; but this being not always possible, and, to prevent any accident in operating where such doubt exists, it is advised to turn the edge of the knife directly upward, thus avoiding the artery in either condition of things.

THE CAVITY OF THE ABDOMEN IN SITU.

Position of the Viscera.—The anterior and lateral walls of the abdomen having been dissected, and the cavity laid open by a vertical and a transverse incision, the exposed parts should be examined in a general way before farther procedure.

The cavity of the abdomen is lined by the serous membrane called the peritoneum, which, like all other structures of the same class, is a shut sac, disposed in such a manner as not only to invest the walls of the cavity, but also to give a partial covering to each one of the contained viscera. But as the arrangement of this membrane cannot be well understood, without some acquaintance with the situation and relations of the organs which it covers, these will first claim attention.

Commencing above and upon the right side, the *liver* is recognized by its large size, reddish-brown color, firm consistence, and singular shape. It will be seen to occupy nearly the whole of the right hypochondriac region, extending across the upper part of the epigastric, and oftentimes reaching as far as the left hypochondriac. Its superior or convex surface corresponds to the concavity of the diaphragm, its inferior to the stomach and bowels, and its anterior margin to the lower edge of the thorax. The gall bladder, the oval-shaped receptacle for the bile, is attached to the under surface of the liver, and somewhat imbedded in its substance. Its situation will be readily discovered by the yellow tinge imparted to the surrounding organs by a *post-mortem* exudation of bile. Deep in the left hypochondrium, and corresponding somewhat in situation to the liver on the opposite side, is the *spleen;* it is of a dark bluish-red color, usually small, and concealed beneath the false ribs, but it is sometimes so much enlarged as to fill almost the whole of this region, extending as low as the left iliac fossa. Between the liver and the spleen, the *stomach* occupies adjacent portions of the left hypochondriac and epigastric regions; it is a large, hollow, conoidal organ, directed from above downward, forward, and to the right side beneath the liver, where its small extremity, called the pylorus, is continuous with the small bowel.

The first division of the small intestine, measuring six or eight inches

in length, is called the *duodenum.* It commences at the small end of the stomach, ascends for a little way obliquely outward to reach the under surface of the liver, then turns vertically downward, and passes along the contiguous borders of the right hypochondriac and epigastric regions, and again horizontally to the left side, lying in the adjacent parts of the epigastric and umbilical regions, and terminates, to the left of the second lumbar vertebra, in the jejunum. To the left of the vertical portion of the duodenum, and extending transversely across the posterior wall of the abdomen behind the stomach, is the *pancreas;* which, however, cannot be seen at present. The *great omentum* is attached along the lower border of the stomach, and spread out in front of the small intestines, but varies very greatly in size in different individuals. It is a membranous apron formed by a folding of the peritoneum upon itself, and incloses numerous vessels and little masses of fat. The small intestine below the duodenum is divided into the *jejunum* and *ileum.* It lies coiled or folded upon itself in the middle, lateral, and inferior parts of the abdominal cavity, and terminates in the right iliac region, where it opens into the colon or large bowel, a few inches above its commencement. The *colon* begins by a large pouch named the *cæcum*, which occupies the right iliac fossa. A small, blind, membranous tube, called the *vermiform appendage*, is attached to its extremity, and is generally found coiled up on its inner and posterior surface. From the right iliac region, the colon ascends (ascending colon) through the back part of the right lumbar to the right hypochondriac region, where it turns, and, becoming transverse (transverse colon), traverses the adjacent borders of the epigastric and umbilical regions, and in the left hypochondrium makes a second turn, and descends (descending colon) through the left lumbar and iliac regions into the pelvis, where, on account of its comparatively straight course along the front of the sacrum to the anus, it is called the *rectum.* Just before reaching the pelvis, it forms a remarkable fold, which, from some slight resemblance in shape to the Greek letter ς, is named the sigmoid flexure.

The **Peritoneum**, by far the most extensive serous membrane in the body, is a shut sac in the male, but is continuous with the lining membrane of the Fallopian tubes in the female. It is so arranged within the abdomen that one part lines the walls of the cavity, constituting what is termed the parietal layer, and the other is thrown around the contained viscera, and is therefore called the visceral layer, furnishing many of them with an almost complete covering. The external surface of the sac is attached to the parts which it invests by areolar tissue, called subperitoneal fascia or areolar tissue, which varies in its density in different situations. The internal surface is smooth and polished, and kept constantly moist by a thin aqueous exhalation; it is always in contact with itself, so

that, strictly speaking, there is no intervening space or cavity except when the parts are pressed asunder by liquid or air.

The *Parietal Layer* lines the superior, anterior, and lateral walls, to which it is connected by the subperitoneal areolar tissue, which, along the linea alba, is close and dense, but, upon each side, comparatively loose and open, and subject to a deposition of fat, especially in the inguinal regions. In the middle line above the umbilicus it forms a vertical fold, called the *falciform* or *suspensory ligament* of the liver, which incloses the fibrous cord resulting from the obliteration of the umbilical vein of the fœtus. Below the umbilicus are three smaller folds, one in the middle line leading downward to the top of the bladder and containing the fibrous remains of the urachus (a structure belonging to fœtal life); and one upon each side inclining downward and outward and inclosing the small cord formed by the closure of the umbilical arteries of the fœtus. With these exceptions, the parietal layer is spread out smoothly upon the walls, and if traced in any direction will be found continuous with the visceral layer.

The *Visceral Layer* is far more extensive than the parietal, in consequence of its numerous reflections or prolongations upon the several organs; and, although at first sight exceedingly complex in its distribution, may, nevertheless, be traced as a continuous layer from one point to another. Without attempting to follow out these numerous reflections—a feat not always easy, and by no means practically important—the student can readily comprehend how it is that the abdominal viscera, although for the most part invested by this membrane, are outside of the cavity of the sac, if he will imagine the abdomen to be empty, but lined with a closed bag made of some very extensible material, and the several viscera subsequently introduced from behind, and pushed forward into their proper places, so as to become covered by the posterior layer of the sac. At the same time, he will understand how the vessels pass to and from these organs between the folds of the peritoneum without perforating it.

Fig. 125.

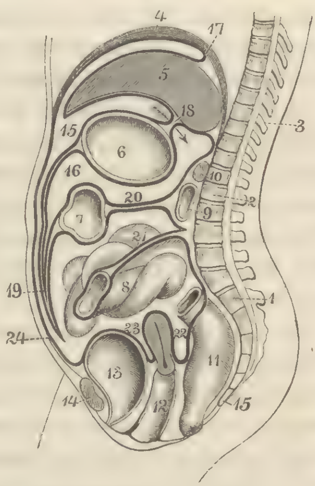


Diagram of reflections of peritoneum in the female in vertical section of abdomen, peritoneum represented by thick, black line. 1, upper segment of sacrum; 2, first lumbar vertebra; 3, dorsal vertebræ; 4, diaphragm; 5, liver; 6, stomach; 7, transverse colon; 8, small intestine; 9, duodenum; 10, pancreas; 11, rectum; 12, vagina and uterus; 13, urinary bladder; 14, pubis; 15, greater cavity of peritoneum; 16, lesser cavity; 17, section of lateral ligament of liver; 18, gastro-hepatic omentum; arrow indicates communication, at right border of latter, of great and lesser cavities of peritoneum; 19, great omentum; 20, transverse mesocolon; 21, mesentery; 22, recto-uterine pouch; 23, vesico-uterine pouch; 24, portion of peritoneum lining anterior wall of abdomen.

The special function of the peritoneum, like that of all serous membranes, is to facilitate the movements of the parts upon each other and to prevent friction; but in addition to this it subserves a most important purpose in confining the organs in their several places.

With these facts in mind, the student should examine the principal reflections or folds, which perform an essential service in retaining the organs in their places, and supporting the bloodvessels in their course to and from the viscera. The most important are:

1. The *Lateral Ligaments of the Liver.* These are formed by the reflection of the peritoneum from the under surface of the diaphragm to the posterior border of the liver, and are the principal means for sustaining the latter organ in its position. The one upon the right is very short and holds the liver in immediate contact with the diaphragm: the one upon the left is nearly an inch in breadth. They are both continuous in the middle line with the suspensory ligament, which has been already referred to in connection with the parietal layer.

2. The *Hepatico-gastric Omentum* is an extension of the peritoneum from the under surface of the liver to the superior curvature of the stomach. Its right border is free, and between its two layers are the hepatic artery, portal vein, hepatic nerves, and hepatic duct. Beneath its right border the serous membrane is pushed as it were behind the stomach to form the lesser cavity of the peritoneum, the constricted point being called the *foramen of Winslow.*

3. The *Gastro-splenic Omentum* is the prolongation of the membrane from the great end of the stomach to the spleen, and is about an inch in length. It is composed of two layers, between which are situated the short arteries (*vasa brevia*), which proceed from the splenic artery to the large extremity of the stomach.

4. The *Gastro-colic* or *Great Omentum*, the largest of the peritoneal folds, hangs from the lower border of the stomach like an apron in front of the small bowel. It varies very greatly in extent in different individuals, being in some cases not more than a few inches in length, and in others reaching as far as the pelvis. It incloses numerous scattered vessels, mostly veins, is commonly the seat of a considerable deposit of adipose tissue, and not unfrequently presents a ragged, torn appearance. It is composed, theoretically at least, of four layers, and is formed by the two layers which, proceeding downward from the stomach, turn back upon themselves to invest the upper and lower surfaces of the transverse colon.

5. The *Mesocolon* is a single fold, consisting of two layers, which attach the large bowel to the posterior wall of the abdomen. It varies very much in length in different situations. Along the transverse colon it is not less than six or eight inches long, and passing from the bowel back to the posterior wall of the abdomen, forms an imperfect septum

between the upper third and the lower two-thirds of the abdominal cavity. Upon the ascending and descending colon it is very short, and its two layers are here separated by a considerable interval, where the bowel is uncovered and in contact with the posterior abdominal wall in the lumbar regions. Upon the sigmoid flexure it is again quite long, and also upon the first part of the rectum (where it is called the mesorectum), thus allowing these portions considerable freedom of movement.

6. The *Mesentery* is the long loose fold in the free margin of which is contained the whole length of the jejunum and ileum. Its posterior border extends obliquely across the posterior wall of the abdomen from the second lumbar vertebra to the right iliac region, measuring only five or six inches in length. Between the two layers of the mesentery are found the superior mesenteric artery and vein with their numerous branches, the lacteal vessels, the mesenteric lymphatic glands, numerous small nerves, and more or less adipose tissue.

7. The *Broad Ligaments of the Uterus* are also folds of the peritoneum. They extend from the sides of the uterus to the lateral walls of the pelvis, and inclose on each side the round ligament, Fallopian tube, and ovary.

VESSELS AND NERVES OF THE ABDOMINAL VISCERA.

Dissection.—Having completed the study of the peritoneum, the next step is to expose the principal vessels and nerves of the several viscera, commencing with those of the liver, stomach, and spleen. For this purpose, the anterior border of the liver should be turned up and fastened by hooks close under the margin of the thorax, and the stomach drawn down. If the latter organ is distended with air, this may be removed by a small puncture, or better by forcing it out through the mouth. Then removing the anterior layer of the hepatico-gastric omentum, the short trunk of the *cœliac artery*, dividing into the *hepatic, gastric,* and *splenic arteries*, will be brought into view. Surrounding the cœliac artery will also be seen the *solar plexus of nerves*, composed of two large flat semilunar masses or ganglia, one on each side, and their numerous intercurrent nerves, consisting of small grayish filaments crossing both above and below the trunk of the vessel.

The **Cœliac Artery** (*cœliac axis*) (Fig. 126, $_1$) is the first single trunk given off by the aorta below the diaphragm. It is very large and short, measuring usually not more than a quarter or half an inch in length. It passes directly forward and divides into three branches, the hepatic, gastric or coronary, and splenic, of which the last mentioned is the largest. Sometimes it also gives off the arteries of the diaphragm.

The **Splenic Artery** (Fig. 126, $_2$), the largest and longest of the three divisions of the cœliac, passes off directly to the left, and running in a very tortuous manner along the superior border of the pancreas, in the substance of which it is partly imbedded, reaches the spleen, where it divides into three or four terminal branches,which enter the fissure of the

organ at different points. It gives off in its course: 1, several large and small twigs to the pancreas; 2, a considerable branch to the stomach and omentum, and hence called the *splenico-gastric* or *left gastro-epiploic artery*,[6] which, passing along the greater curvature of the stomach, between the anterior two layers of the great omentum, anastomoses with the hepatico-gastric or left gastro-epiploic; 3, five or six small twigs called *gastric branches* or *vasa brevia*,[7] which, coming from the terminal divisions of the artery in the fissure of the spleen, run a retrograde course between the layers of the gastro-splenic omentum, to the great extremity of the stomach upon which they are distributed.

Fig. 126.

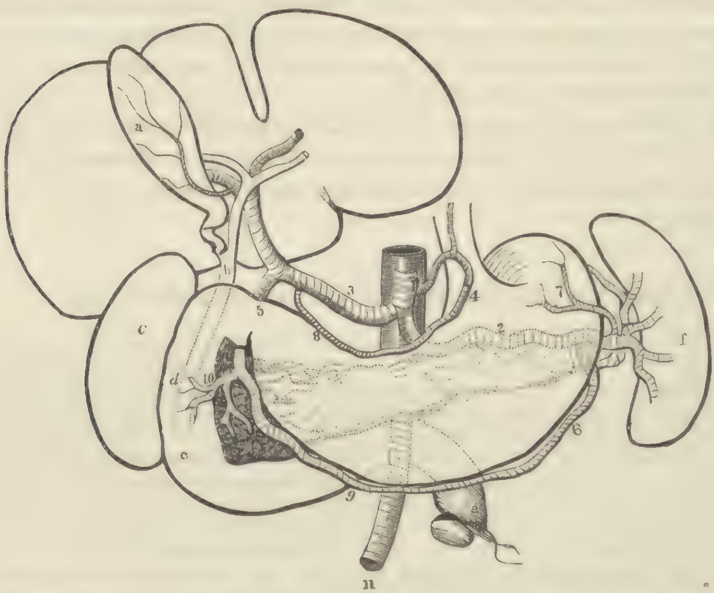


Diagram of branches of cœliac artery; pancreas represented in dotted outline behind the stomach. 1, cœliac artery; 2, splenic artery; 3, hepatic artery; 4, coronary artery; 5, gastro-duodenal artery; 6, left gastro-epiploic artery; 7, vasa brevia; 8, pyloric artery; 9, right gastro-epiploic artery; 10, pancreatico-duodenal artery; 11, superior mesenteric artery; 12, cystic artery. *a*, gall bladder; *b*, bile duct; *c*, kidney; *d*, descending duodenum; *e*, termination of bile duct; *f*, spleen; *g*, commencement of jejunum.

The **Hepatic Artery** (Fig. 126, 3), the second in point of size of the three branches, passes for a short distance transversely to the right, and then ascends obliquely forward between the two layers of the hepatico-gastric omentum, having the portal vein and common bile duct on its right, and enters the transverse fissure of the liver, where it divides into two branches, one for each lobe.

Branches.—Before entering the liver, the hepatic artery sends off three principal branches: 1. The *pyloric*,[8] a small twig which turns off to the left near the pyloric or smaller extremity of the stomach, and running

along the superior curvature of this organ, between the two layers of the hepatico-gastric omentum, is distributed to the anterior and posterior surfaces of the former. 2. The *gastro-duodenal*[5] is much larger than the preceding, and originates near it. It descends behind the commencement of the duodenum to divide into the *pancreatico-duodenal*,[10] which is distributed to the duodenum and the adjacent head of the pancreas, and the *hepatico-gastric* or *right gastro-epiploic*,[9] which passes along the inferior curvature of the stomach between the anterior two layers of the great omentum, and is distributed for the most part to the stomach, a few twigs descending into the omentum. 3. The *cystic*,[12] a very small branch, originates from the right of the two terminal divisions of the hepatic within the transverse fissure of the liver, and, passing forward, ramifies between the coats of the gall bladder.

The **Coronary** or **Gastric Artery**,[4] the smallest of the three branches of the cœliac, ascends to the left, and having furnished a small branch, the *œsophageal*, to the gastric extremity of the œsophagus, makes an abrupt bend to the right, and, passing along the upper curvature of the stomach, anastomoses with the pyloric. It also not unfrequently sends a large branch to the liver.

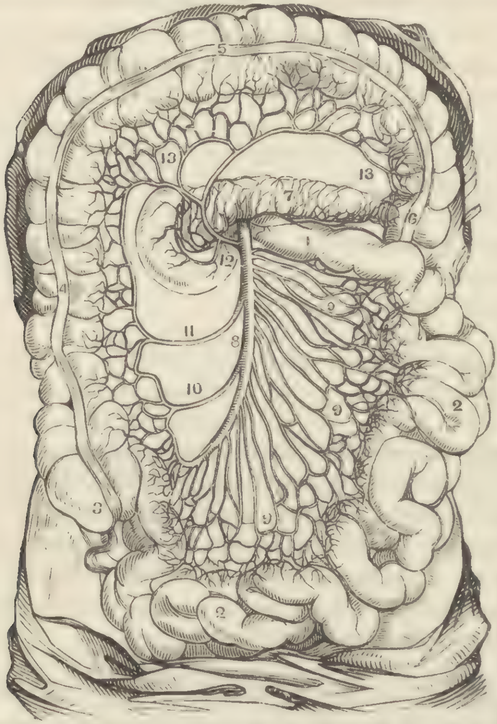
The **Solar Plexus of Nerves**, the great centre of the sympathetic system, is also seen in this dissection. It consists of two flattened, grayish crescentic bodies, called the *semilunar ganglia*, each about the size of small butter-bean, and connected together by almost numberless nervous filaments. The ganglia are placed upon either side of the cœliac artery, and the connecting filaments cross the front of the aorta above and below the same. From this plexus most of the abdominal viscera receive their nervous supplies. Its branches ramify in company with the bloodvessels, form numerous smaller plexuses, to be hereafter described, and finally terminate in the substance of the organs.

Dissection.—Turn the small intestine to the left side, and feeling for the trunk of the superior mesenteric artery, immediately below the middle of the transverse mesocolon, dissect off the right layer of the mesentery, taking care not to wound the mesenteric veins, which lie for the most part upon the surface of the arteries. If the veins, however, are much in the way, tie the main trunk. and remove the smaller branches entirely. A previous examination of the accompanying plate will materially aid in the performance of the dissection. Some notice should also be taken of the lymphatic glands, called here the *mesenteric glands*, which abound in this situation. The lacteal vessels that penetrate these glands on their way from the intestines to the thoracic duct, may also be seen upon very close inspection, but it is not desirable to attempt their dissection at present.

The Superior Mesenteric Artery (Fig. 127) is the second single branch given off by the aorta below the diaphragm, and originates immediately below and frequently by a common trunk with the cœliac. It is at first placed behind the pancreas, which lies upon the poste-

rior wall of the abdomen at this point, but soon emerging between the inferior margin of this organ and the transverse portion of the duodenum, it descends between the two layers of the mesentery toward the right iliac region, describing a slight curve with its convexity toward the small intestines. Its branches are numerous, and many of them are quite large. While behind the pancreas, it furnishes small twigs to the head of this organ, and to the duodenum,[12] and occasionally a large branch to the liver; within the mesentery, it divides into numerous large branches,

Fig. 127.



View of superior mesenteric artery and branches, together with some of the associated parts, the small intestine having been turned down. 1, duodenum; 2, jejunum and ileum; 3, cæcum; 4, right ascending colon; 5, transverse arch of colon; 6, left descending colon; 7, pancreas; 8, superior mesenteric artery; 9, 9, 9, arteries of small intestine, twelve or fourteen in number; 10, ileo-colic artery; 11, right colic artery; 12, inferior pancreatico-duodenal artery; 13, 13, middle colic artery.

distributed to the small intestine, to the cæcum, the ascending and the transverse colon.

The *Arteries of the Small Intestine* (vasa intestini tenuis), twelve or fifteen in number, originate from the convexity of the superior mesenteric, and, passing forward, divide and subdivide into still smaller branches, which anastomose freely with each other, and form three or four series of most beautiful arches. These diminish successively in size, but increase in number, until the twigs extend from the last row into the coats of the bowel.

The Branches going to the Large Intestine consist of three principal trunks, which come off from the concavity of the curve: they are, the ileo-colic, right colic, and middle colic, the last two often originating by a common trunk. The *ileo-colic*[10] is the proper continuation of the main trunk of the superior mesenteric, and is distributed, as its name indicates, to the commencement of the colon, and the adjacent extremity of the ileum; it is inclosed in the lower border of the mesentery. The *right colic*[11] (colica dextra) passes nearly transversely to the right, along the posterior wall of the abdomen, behind the peritoneum, and is spent upon the ascending colon in the right lumbar region, anastomosing below with the preceding. The *middle colic*[13] (colica media) originates immediately beneath the margin of the pancreas, and, ascending a little to the right, enters the transverse mesocolon, and is distributed principally to the corresponding division of the large bowel. It anastomoses, on the one hand, with the right colic,* and on the other, with the left colic, a branch of the inferior mesenteric.

The **Superior Mesenteric Vein** (Fig. 143, *e*) is formed by the union of smaller veins which accompany the branches of the superior mesenteric artery. It is very large, and situated to the right, and a little in front of the trunk of the artery where it crosses the transverse portion of the duodenum. It unites with the splenic vein behind the pancreas, to form the main trunk of the portal system, to be hereafter described.

The **Mesenteric Glands** vary in number from fifty to a hundred or more, and in size, from that of a large grain of wheat to that of an ordinary white bean. They may be readily recognized by their pale fleshy color, oval or rounded figure, and firm consistence. They exist in greatest numbers along the posterior or spinal border of the mesentery, and are not often found nearer than within two inches of the intestine. The lacteals pass through these glands before terminating in the thoracic duct.

The **Lymphatics** will be described in connection with the Abdominal Viscera (p. 264).

Dissection.—Turn the small intestine to the right side and dissect off the peritoneum which covers the posterior wall of the abdomen between the attached border of the mesentery and the descending colon.

The **Inferior Mesenteric Artery** (Fig. 128) is much smaller than the superior. It originates from the aorta, at least two inches below the former, descends for a short distance behind the peritoneum, and divides into three principal branches (Fig. 128, $_{11, 13, 14}$), the left colic, the sigmoid and the superior hemorrhoidal.

The *left colic* (colica sinistra), the second in size of the three branches, passes transversely outward, and is distributed to the descending colon in

* This is one of the largest arterial anastomoses in the body.

the left lumbar region; it anastomoses above with the middle colic, a branch of the superior mesenteric.

The *sigmoid*, often a branch of the preceding, passes outward and downward, and is spent upon the sigmoid flexure.

Fig. 128.

View of distribution of inferior mesenteric artery, its connections with superior mesenteric, etc. 1, transverse colon; 2, descending colon; 3, sigmoid flexure; 4, rectum; 5, small intestine; 6, pancreas; 7, superior mesenteric artery; 8, middle colic of superior mesenteric; 9, arteries of small intestine from superior mesenteric; 10, aorta; 11, left colic; 12, trunk of inferior mesenteric artery; 13, superior hemorrhoidal; 14, sigmoid or inferior colic artery.

The *superior hemorrhoidal*, the largest of the three, descends almost parallel with and along the left side of the aorta into the pelvis, where it enters the mesorectum, and is distributed to the superior part of the corresponding division of the bowel.

The **Inferior Mesenteric Vein** (Fig. 143) is formed by the union of branches corresponding to the divisions of the artery. It ascends along the left side of the aorta, and opens into the splenic vein.

Removal of the Abdominal Viscera. Dissection.—The abdominal organs, having been examined *in situ*, should now be removed entire, and laid aside for more particular study after the superior and posterior walls of the cavity have been dissected. For this purpose, place a ligature upon the œsophagus at its termination, and another upon the middle of the rectum, and divide these two tubes beyond the points where they are tied. Next, dissect the liver from the diaphragm, by dividing the suspensory and lateral ligaments and the inferior cava vein, where it passes through the posterior margin of the organ to perforate the diaphragm. Great care is necessary to avoid cutting through the diaphragm.

and thus relaxing it by the admission of air into the cavity of the thorax. This done, draw the organs down, divide the cava vein again about two inches below, then the branches of the cœliac axis, the superior mesenteric artery, the transverse mesocolon, the mesentery, the inferior mesenteric artery, the mesocolon on each side, and the mesorectum, aiding the dissection by means of firm traction from above downward and forward. In cutting through the mesocolon on each side, and the mesentery, pains must be taken not to wound or remove the kidneys and suprarenal capsules, which are situated in the lumbar regions behind the peritoneum.

The viscera having been laid aside for subsequent examination, the peritoneum, areolar tissue, and fat, should be carefully removed from the surface of the diaphragm and the posterior abdominal walls, in order to display the muscles, vessels, and nerves in this situation.

The dissection of the peritoneum from the surface of the diaphragm will require care and perseverance, but if the muscle has not been perforated in the removal of the liver, its beautiful concave surface can be entirely exposed, and the student will be amply repaid for his labor. If, however, the muscle has been relaxed by the admission of air into the thorax, it will be useless to spend time upon it.

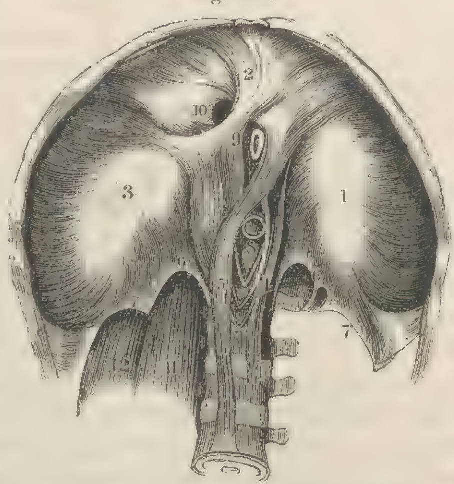
In dissecting the posterior wall, the kidneys and suprarenal capsules may be turned to one side or the other, but should not be detached from their connection to the aorta and inferior cava. Compared with the labor necessary to expose the diaphragm, the dissection here is comparatively easy, but may seem somewhat tedious to one who has not a sufficient appreciation of the beautiful in anatomy, to spend an hour or two in cleaning away the fat and other loose tissues, that obscure the view of one of the most interesting parts of the body.

MUSCLES OF THE SUPERIOR AND POSTERIOR ABDOMINAL WALLS.

The Superior Wall of the Abdomen is formed exclusively by the diaphragm; the Posterior, on each side of the lumbar vertebræ, by the great and small psoas, the iliac, and the square lumbar muscles, and a part of the diaphragm.

The Diaphragm (Figs. 129 and 130) is situated between the abdominal and thoracic cavities, forming the roof of the former and the floor of the latter. In shape, it bears a remarkable resemblance to an umbelliferous leaf, and consists therefore of a vertical and a horizontal portion, the former representing the stem, and the latter the expansion of the leaf.

Fig. 129.



Inferior view of diaphragm. 1, 2, 3, three lobes of tendinous centre, surrounded by fleshy fasciculi derived from inferior margin of thorax, the crura, 4, 5, and the arcuate ligaments, 6, 7; 8, aortic opening; 9, œsophageal opening; 10, opening for passage of cava vein; 11, psoas muscle; 12, square lumbar muscle.

The *Vertical Portion* is formed by the two parallel muscular bundles, called *pillars* or *crura*, lying upon the front of

the spine. The right is anterior and larger than the other; it originates by tendinous slips from the bodies and interosseous substance of the first four lumbar vertebræ; the left arises in like manner, but reaches only as low as the third. From the tendinous slips, the fleshy bellies ascend to be inserted into the middle of the horizontal portion behind; but before reaching this point there is an interchange of fibres, a small bundle from each arching over to the opposite side, so as to leave below an oblique, elliptical opening for the transmission of the aorta; these then diverge, and again approach each other above to surround the circular opening for the œsophagus.

Fig. 130.

View of diaphragm during expiration 1, superior extremity of sternum; 2, first rib; 3, dorsal region of spine; 4, superior surface of central tendon of diaphragm; 5, right lateral portion of diaphragm; 6, left lateral portion; 7, xiphoid cartilage; 8, right crus or pillar of diaphragm; 9, left pillar; 10, body of third lumbar vertebra; 11, posterior fibres of diaphragm; 12, aorta passing between and behind pillars of diaphragm.

The *Horizontal Portion* of the diaphragm is thin and membranous, tendinous at the centre, but fleshy at the circumference. It is transversely elliptical, deeply concave below and convex above, the convexity on the right side reaching as high as the fourth intercostal space, and, on the left, as high as the fifth. Its margin is attached to the inner aspect of the lower border of the thorax, as far round on each side as the twelfth rib, indigitating with the insertion of the transverse muscle of the abdomen. From the extremity of the twelfth rib to the transverse process of the first lumbar vertebra, and from the latter point to the side of the body of the same bone, it forms two fibrous arches, called the *external* and *internal arcuate ligaments;* the former is much the longer of the two, and crosses the front of the upper part of the square lumbar muscle; the latter covers the upper extremity of the psoas. From the attached margin or circumference the fleshy fibres converge in an arched manner toward the central aponeurosis, called the *cordiform tendon*, which is somewhat heart-shaped, with the apex rounded, and presenting toward the ensiform cartilage. This tendon is perforated behind and a little to the right, for the passage of the inferior cava vein.

The *Openings* in the diaphragm are three in number, the aortic, the œsophageal, and the opening for the inferior cava. The aortic opening is situated between the vertical pillars, and in front of the body of the

first lumbar vertebra, a little to the left of the median line. It is oval in an oblique direction, and, besides the aorta, transmits the azygos vein, thoracic duct, and sometimes the left great splanchnic nerve. The œsophageal opening, also in the fleshy part of the muscle, is situated above and a little to the left of the aortic; it is also oval, about three-quarters of an inch in diameter, and occupied by the œsophagus and the pneumogastric nerves. The opening for the cava vein occurs in the tendinous portion of the muscle, and is situated to the right of and a little higher than the preceding; it is quadrangular, and gives passage only to the inferior cava vein.

Relations.—The vertical portion of the diaphragm rests upon the front and sides of the bodies of the lumbar vertebræ; its anterior surface is in relation with the aorta and inferior cava, is crossed about its middle by the pancreas, and below by the transverse mesocolon and the horizontal portion of the duodenum, and is embraced above by the large notch in the posterior margin of the liver. The horizontal portion is in contact upon its superior or convex surface, laterally, with the base of the lungs, and in the middle with the pericardium and the heart. Its inferior surface is in relation on the right side with the right lobe of the liver, the right kidney, and its suprarenal capsule; on the left, with the great extremity of the stomach, the spleen, the pancreas, and the left kidney and its capsule.

Action.—The diaphragm is an active muscle of inspiration; its contraction tends to increase the vertical diameter of the thorax at the expense of the abdomen, whose anterior and lateral walls yield, under ordinary circumstances, in a like proportion. But it is also a powerful aid in difficult defecation, micturition, parturition, etc., in which cases its action, conjoined with that of the anterior and lateral abdominal muscles already described, compresses the contained viscera in the direction of the diagonal of the forces, or, in other words, in the direction of the outlets of the body.

Four muscles form the posterior wall of the abdomen upon each side of the lumbar vertebræ; they are, the small and large psoas, the iliac, and the square lumbar muscles.

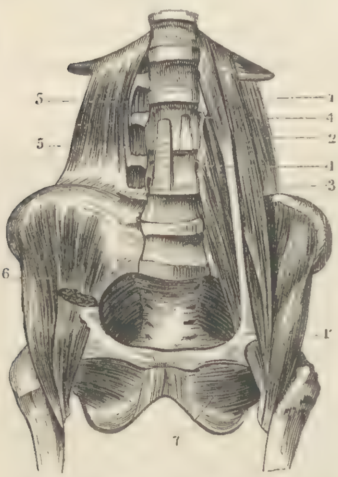
The **Small Psoas Muscle** (*psoas parvus*) (Fig. 131) is more often wanting than present, and when present is frequently found upon only one side. It originates from the sides of the bodies of the last dorsal and one or two adjacent lumbar vertebræ, forms a small conical or flattened fleshy bundle two or three inches in length, and then terminates in a long flat tendon, which, descending a little outward, is inserted into the ilio-pectineal eminence, and into the fascia covering the iliac muscle.

Use.—To make the iliac fascia tense, and to assist in flexing the trunk upon the pelvis, or conversely.

The **Iliac Fascia** covers the iliac and large psoas muscles, and is attached to the inner aspect of the crest of the ilium, the lateral margin of the superior strait of the pelvis, and to the external two-thirds of the crural arch. Over the iliac muscle, it is usually a dense aponeurotic membrane, but upon the surface of the psoas it is more delicate, and, if traced downward along the inner border of the latter, will be found to unite with the pelvic fascia to form the posterior half of the sheath of the iliac artery and vein, where these vessels pass beneath the crural arch to the thigh, the anterior half of this sheath being formed by the transverse fascia. The presence of this fascia explains the uniform course of psoas abscess toward the thigh and its final pointing below the crural arch. As one of the structures entering into the anatomy of femoral hernia, this fascia will hereafter claim particular attention, and for this purpose should be left for the present untouched upon one side of the abdomen.

The **Large Psoas Muscle** (*psoas magnus*) (Fig. 131) is situated in the posterior part of the lumbar and iliac regions, next to the spine, where it forms a large conoidal fleshy mass, known as the *tender loin* in the inferior animals. It originates from the sides of the bodies and roots of the transverse processes of the last dorsal and four upper lumbar vertebræ, and from the corresponding intervertebral cartilages, descends along the lateral margin of the superior strait of the pelvis, and, passing beneath the crural arch, is inserted, by a tendon, common with the iliac muscle, into the small trochanter of the femur. The line of its origin is marked by a number of beautiful fibrous arches which span the horizontal constrictions of the lumbar vertebræ for the passage of the lumbar arteries and veins.

Fig. 131.



Muscles of posterior wall of abdomen. 1, small psoas muscle; 1′, insertion of its tendon into iliac fascia cut; 2, large psoas muscle; 3, square lumbar muscle, partly concealed by two psoas muscles; 4, 4, foramina formed by grooves upon bodies of lumbar vertebræ, and origins of great psoas muscle, for passage of lumbar arteries and veins; 5, 5, intertransverse muscles; 6, iliac muscle entirely exposed by removal of great psoas muscle; 7, obturator externus.

Relations.—The superior extremity of the psoas is overlapped by the internal arcuate ligament, and is, therefore, properly within the thorax. Below this point it is in contact with the lower end of the kidney; it is crossed obliquely at its middle by the ureter, and on the left side by the rectum; still lower it is crossed by the seminal tube, and lastly by the

crural arch. It rests upon the square lumbar muscle above, and is here involved with the lumbar plexus of nerves, which is somewhat imbedded in its substance behind. Its inner border overhangs the superior strait of the pelvis, and has resting against it the primitive and external iliac arteries and veins; its outer border forms, with the iliac muscle, a kind of groove, in which the crural nerve is placed on its way from the lumbar plexus to the thigh. A small nerve, called the genito-crural, perforates the upper part of the muscle, and passes down upon its anterior surface.

Use.—To flex the thigh upon the pelvis, and at the same time to rotate it outward; or, if the thigh is the fixed point, to flex the trunk upon the femur, and, if only one muscle acts, to turn it to the opposite side.

The **Iliac Muscle** (Fig. 131) (*iliacus internus*) occupies the iliac fossa, and originates from the surface upon which it rests, the transverse process of the fifth lumbar vertebra, the ilio-lumbar ligament, and the lateral surface of the base of the sacrum. From these points the fibres converge, descend forward over the shallow groove between the ilio-pectineal eminence and inferior iliac spine, a large bursa intervening, and over the ilio-femoral articulation, to be inserted, by a tendon common with the psoas, into the small trochanter of the femur. In passing over the margin of the pelvis, a few fleshy fibres, from the inferior spine of the ilium, are added to the outer border of the muscle, and are inserted a little below the trochanter.

Relations.—Each muscle is crossed from within outward by the ilio-scrotal nerve, and covered by the iliac fascia, which separates the right from the cæcum and vermiform appendage, and the left from the sigmoid flexure of the colon. In the thigh it rests upon the capsular ligament of the hip joint between the heads of the sartorius and pectineus muscles. The action of this muscle is similar to that of the preceding.

The **Square Lumbar Muscle** (Fig. 131) (*quadratus lumborum*) is situated in the back part of the lumbar region, between the twelfth rib and the crest of the ilium. It is inclosed between two layers of the lumbar fascia, the anterior of which should be dissected off, commencing at the outer border of the muscle and turning it toward the spine. It originates fleshy and tendinous from the ilio-lumbar ligament, from a small part of the adjacent iliac crest, and, by accessory slips, from the transverse processes of the second, third, and fourth lumbar vertebræ. From these points it ascends in the form of a quadrangular mass, flattened from before backward, and is inserted into the inferior margin of the last rib.

Relations.—Anteriorly, the muscle is crossed above by the external arcuate ligament of the diaphragm, below this point by the two musculo-cutaneous nerves; and is in contact with the lower extremity of the kidney. But its most important relation is that with the colon, from which

it is separated only by the anterior layer of the lumbar fascia, thus rendering it possible for the surgeon to reach the bowel without opening the peritoneal sac. Posteriorly, it is separated from the erector muscle of the spine by the middle layer of the lumbar fascia.

Use.—To depress the last rib, and thus assist in expiration; to bend the spine to one side or the other, and, both acting at the same time, to assist in supporting the trunk in a vertical position.

Dissection.—Cut the square and psoas muscles from their attachments, and remove the former from the body so as to get a view of the middle layer of the lumbar fascia. Turn down the psoas, and cut it off at the crural arch.

The **Lumbar Fascia** consists of three layers, of which the two seen in this dissection are comparatively thin, but the third, which covers the posterior surface of the erector muscle of the spine in the lumbar region, is an exceedingly dense and strong aponeurosis. The anterior layer forms the anterior portion of the sheath of the square muscle: it is attached, internally, to the roots of the transverse processes of the lumbar vertebræ; below, to the crest of the ilium; above, to the external arcuate margin of the diaphragm. The middle layer lies behind the square muscle, is attached to the extremities of the transverse processes of the lumbar vertebræ, above to the twelfth rib, below to the crest of the ilium, and, at the outer border of the square muscle, unites with the anterior layer to give origin to the middle portion of the transverse muscle of the abdomen.

BLOODVESSELS AND LYMPHATICS OF THE POSTERIOR REGION OF THE ABDOMEN.

The Arteries found upon the posterior wall of the abdomen are the abdominal aorta and its branches.

The **Abdominal Aorta** (Fig. 132, 1) is the third division of the primary stem or trunk, from which all the arteries in the body originate, the first and second divisions being contained within the thorax. It enters the abdomen through the aortic opening between the pillars of the diaphragm, descends in front of the spine a little to the left of the median line, and, having reached the fourth lumbar vertebra, terminates by dividing into the two common or primitive iliac arteries. At its entrance it is quite large, measuring nearly three-quarters of an inch in diameter, but it gradually diminishes in size, so that, at its bifurcation, its diameter rarely exceeds two-fifths or half an inch.

Relations.—It rests upon the bodies of the vertebræ and the anterior margins of the corresponding intervertebral fibro-cartilages, being separated from them only by the anterior common ligament of the spine. It is crossed in front by the posterior border of the liver, the pancreas, the horizontal portion of the duodenum, the transverse mesocolon, the left

renal vein, and the attached border of the mesentery. On the right side, it is in contact with the right pillar of the diaphragm, the inferior cava vein, the right semilunar ganglion, the commencement of the right azygos vein, and of the thoracic duct; on the left, with the left pillar of the diaphragm, the left semilunar ganglion, and the left common trunk of the sympathetic nerve.

The branches of the aorta are either single or in pairs. The former, commencing above, are, the cœliac, superior mesenteric, inferior mesenteric, and middle sacral; the latter are, the phrenic or diaphragmatic, middle suprarenal, renal or emulgent, spermatic, and lumbar.

The **Cœliac Artery** (Fig. 132, $_3$), the largest of all the branches of the abdominal aorta except the common iliac arteries, originates from the anterior aspect of this vessel about half an inch below the anterior margin of the aortic opening of the diaphragm, passes horizontally forward to the distance of a quarter of an inch or more, and divides into three branches, namely, the hepatic, splenic, and gastric, which have been already described.

Relations.—It is in contact, laterally, with the semilunar ganglia; above, with the nerves connecting the ganglia; and inferiorly, with similar nervous filaments and the superior border of the pancreas.

The **Superior Mesenteric Artery** (Fig. 132, $_4$), the next largest branch, commences about half an inch below the cœliac, descends forward between the pancreas above and the transverse portion of the duodenum below, enters the mesentery and is distributed to the small intestine, the cæcum, and the ascending and transverse colon, as already seen (p. 245).

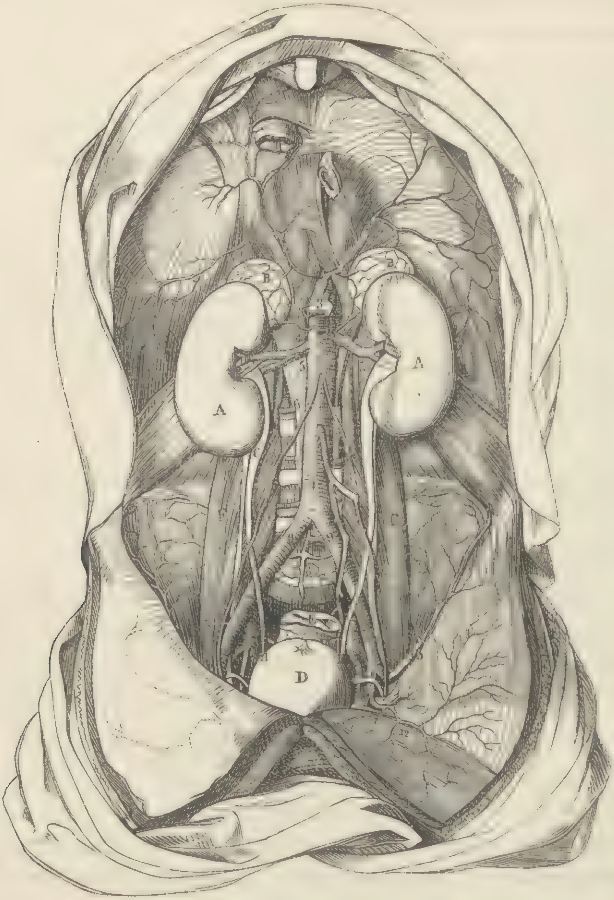
The **Inferior Mesenteric Artery** (Fig. 132, $_7$), much smaller than the preceding, arises from the front of the aorta some distance below, passes downward and toward the left side behind the peritoneum, and divides into the left colic, sigmoid, and superior hemorrhoidal arteries, which are distributed to the descending colon and upper part of the rectum.

The **Middle Sacral Artery** (Fig. 132, $_8$) is a very small branch coming from the posterior aspect of the aorta at its bifurcation. As its name signifies, it rests upon the middle of the sacrum, and is distributed to the adjacent structures. Some of the branches enter the anterior sacral foramina, and emerge at the posterior, to reach the muscular mass in this situation.

The **Diaphragmatic** or **Phrenic Arteries** (Fig. 132, $_{2,2}$), two in number, are generally the first branches given off by the abdominal aorta, from whose lateral aspect they pass upward, and diverge to be distributed to the under surface of the diaphragm, sending also small branches to the

suprarenal capsules and the gastric extremity of the œsophagus. They sometimes originate by a single trunk from the front of the aorta, or from the cœliac artery.

Fig. 132.



Abdominal aorta and its branches. 1, 1, trunk of abdominal aorta; 2, 2, inferior diaphragmatic arteries; 3, cœliac artery; 4, origin of superior mesenteric; 5, 5, renal arteries; 6, 6, spermatic arteries; 7, inferior mesenteric artery; 8, middle sacral; 9, 9, primitive iliacs; 10, 10, external iliacs; 11, 11, internal iliacs; 12, epigastric artery; 13, circumflex iliac; 14, 14, middle suprarenal. **A, A, kidneys; B, B, suprarenal capsules; C, C, ureter; D, bladder; E, rectum; F, F, psoas muscles.**

The **Middle Suprarenal Arteries** (Fig. 132, $_{14, 14}$) are very small, and come from the sides of the aorta nearly upon a line with the superior mesenteric, but not infrequently from the cœliac, and are distributed to the suprarenal capsules. They are designated *middle* to distinguish them from the superior, which are branches of the diaphragmatic, and the inferior, which come from the renal arteries.

The **Renal** or **Emulgent Arteries** (Fig. 132, $_{5, 5}$) pass off at right angles from the sides of the aorta opposite the upper lumbar vertebra; the right is a little lower than the left, and also longer, from having to cross behind the inferior cava to reach its destination. They are remarkable for their relatively large size, and for the numerous varieties which they present both in number and origin. They are not infrequently double, or sometimes even triple, on one or both sides, and arise from different parts of the aorta, or from some of its branches.* They are covered in front by the peritoneum, and generally by the corresponding renal veins, the left lying also behind the inferior cava. Before entering the fissure of the kidney, they divide into three or four branches, which are distributed to the different parts of this organ.

The **Spermatic Arteries** (Fig. 132, $_{6, 6}$) usually come off separately a short distance below the renal, but sometimes by a single short trunk from the front of the aorta, and occasionally one or both of them from the renal arteries. They are quite small, but very long; descend obliquely outward behind the peritoneum, and, accompanied by the spermatic veins, they enter the internal abdominal ring, traverse the inguinal canal, forming one of the constituents of the spermatic cord, and are distributed principally to the testes. In the female, they take the same direction as far as the ovaries, and are distributed to these organs, to the Fallopian tubes, and to the sides of the uterus.

The **Lumbar Arteries** consist of four or five pairs, which originate from the posterior aspect of the aorta, opposite the body of each lumbar vertebra; and curving backward beneath the little tendinous arches that are placed here for their protection, divide into an anterior and a posterior set of branches, the former distributed to the lateral and anterior walls of the abdomen, and the latter to the muscles of the back and to the spinal cord.

The **Common** or **Primitive Iliac Arteries** (Fig, 132, $_{9, 9}$) are the two terminal divisions of the aorta, whose bifurcation is situated in front of the lower margin of the fourth lumbar vertebra. From their origin, they diverge at an acute angle, pass obliquely downward, forward, and outward, lying along the brim of the pelvis and the inner border of the psoas muscles, and, opposite the sacro-iliac symphysis, they divide on each side into the internal and external iliac arteries, the former intended for the parts contained within the pelvis, and the latter for the inferior extremity. They are very large, but short, rarely measuring more than two or two and a half inches in length, straight, but often curved with the concavity presenting upward, and give off no large branches. They

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* In a preparation in the museum of the author there are four renal arteries on one side, and three on the other, all coming from the aorta.

are covered upon their inner and superior aspect by the peritoneum, are both crossed by the ureters, and the left one also by the hemorrhoidal branch of the inferior mesenteric artery. Their relations with the common iliac veins are not precisely the same, for although each vein is situated behind and below its corresponding artery, the left, in crossing the posterior margin of the brim of the pelvis to reach the inferior cava vein, which is situated to the right of the aorta, passes beneath the commencement of the right artery.

The **External Iliac Arteries** (Fig. 132, $_{10, 10}$) are the continuations of the common iliac. The artery upon either side descends forward and a little outward, upon the inner border of the psoas muscle, to the crural arch, beneath which it passes, and is then called the femoral artery. It is covered superiorly by the peritoneum, and is crossed, the right, by the lower extremity of the small intestine, and the left, by the sigmoid flexure of the colon. Beneath the crural arch, the psoas muscle is upon its outer, and the external iliac vein upon its inner side; but, within the abdomen, the vein is below. Its branches are the epigastric and circumflex iliac arteries.

The **Epigastric Artery** (Fig. 132, $_{12}$) arises from the inner aspect of the external iliac, directly beneath or a few lines above the crural arch; it passes for a little way almost horizontally inward and forward, and is then reflected upward and inward, upon the posterior surface of the anterior wall of the abdomen. It lies along the inner side of the internal inguinal ring, and, entering the sheath of the straight muscle, is distributed to the surrounding parts, some of its branches reaching nearly as high as the margin of the thorax, and anastomosing with the internal mammary, a branch of the subclavian.

The **Obturator Artery**, which is usually a branch of the internal iliac, is sometimes given off by the epigastric. In the latter case it may descend inward, along the posterior aspect of the crural arch, above the entrance of the crural canal, and then turn downward along the free border of Gimbernat's ligament, or it may pass directly downward, along the outer boundary of the entrance of the canal, to reach the opening in the obturator membrane.

The **Circumflex Iliac Artery** (Fig. 132, $_{13}$) is somewhat smaller than the preceding. It comes off from the outer side of the external iliac, just beneath the crural arch, and passes upward and outward behind the arch as far as the anterior superior spine of the ilium. Here it divides into two branches, one of which ascends in the substance of the anterior abdominal wall, and the other winds along the iliac crest between the external oblique and transverse muscles, and anastomoses with the ilio-lumbar, a branch of the internal iliac.

The **Internal Iliac Artery** originates from the bifurcation of the primitive iliac, descends vertically in front of the sacro-iliac symphysis, and breaks up into a number of branches which will be described in connection with the contents of the pelvis.

The Veins found upon the posterior wall of the abdomen for the most part accompany corresponding arteries, and open into the inferior cava vein, which forms the main channel through which all the venous blood from the inferior extremities and the subdiaphragmatic division of the trunk is returned to the heart. The veins, however, from the digestive organs (the stomach, small and large intestines, and pancreas) and the spleen unite to form a common trunk, called the portal vein, which ramifies like an artery through the substance of the liver; but the blood which it conveys to this organ ultimately reaches the inferior cava by the hepatic veins, as will be hereafter described.

The **Inferior** or **Ascending Cava Vein,** the largest venous trunk in the body, commences opposite the fourth lumbar vertebra, by the union of the two common iliac veins. It ascends in front of the spine along the right side of the aorta, and, therefore, a little to the right of the median line, and, having traversed the quadrangular orifice in the tendinous portion of the diaphragm, opens almost immediately into the right auricle of the heart. In its course, it receives the common iliac veins, the middle sacral, lumbar, spermatic, renal, suprarenal, hepatic, and diaphragmatic veins.

The **External Iliac Vein** is the continuation of the femoral vein within the abdomen. It is situated, while under the crural arch, close to the inner side of the artery, but, passing backward to join the internal iliac, it gradually gains the under surface of the artery, resting upon the inner border of the psoas muscle. Near the crural arch it receives the epigastric and circumflex iliac veins, which accompany the arteries of the same name. Between the inner border of the external iliac vein, where it is continuous with the femoral, and with the crescentic edge of Gimbernat's ligament, and beneath the internal extremity of the crural arch, is the transversely-oval opening known as the internal crural ring, or the entrance to the crural canal, to be hereafter described in connection with crural hernia.

The **Internal Iliac Vein** accompanies the internal iliac artery, and will be seen in the dissection of the contents of the pelvis.

The **Common Iliac Vein** results from the union of the external and internal iliacs, and commences, therefore, opposite the sacro-iliac symphysis; thence it ascends backward and inward, to unite with its fellow

of the opposite side at the commencement of the inferior cava. The right vein crosses the corresponding artery obliquely behind to reach its outer aspect; the left, larger than the right, is at first beneath and parallel to its corresponding artery, but subsequently it crosses the front of the last lumbar vertebra, beneath the right artery at its commencement.

The **Middle Sacral Vein** is very small; it corresponds to the artery of the same name, and opens into the commencement of the cava vein behind.

The **Lumbar Veins,** three or four on each side, receive the blood from the muscles of the loins, and from the lower part of the spinal cord, and, winding around the lumbar vertebræ in company with the lumbar arteries, open into the adjacent back part of the cava.

The **Spermatic Veins,** one on each side, are quite small, pass obliquely upward from the internal inguinal ring alongside of the spermatic arteries, and open, the right into the inferior cava, and the left into the left renal vein.

The **Renal** or **Emulgent Veins** are generally single on each side, and very large. They pass transversely from the fissure of the kidney into the adjacent part of the cava. The left is the longer of the two; it receives the left spermatic vein at a right angle, and crosses the front of the aorta.

The **Suprarenal Veins**, one on each side, are very small, and, as their name indicates, come from the suprarenal capsules. The right terminates in the cava, and the left in the renal vein.

The **Hepatic Veins** will be seen in the examination of the liver, from the notch of whose posterior border they emerge, and terminate immediately in the inferior cava.

The **Diaphragmatic Veins,** two on each side, accompany the diaphragmatic arteries, and generally terminate in the cava just at its entrance into the tendinous opening of the diaphragm; but they sometimes empty into the hepatic veins.

The **Azygos Veins**, two in number, belong more properly to the anatomy of the thorax, but their commencement in the abdomen may be seen in this dissection.

The *right* or *greater azygos* commences upon the right side of the bodies of the lumbar vertebræ, by communications with the inferior cava and the lumbar veins. It ascends in front of the roots of the transverse processes, and, entering the thorax through the aortic opening of the di-

aphragm, becomes much enlarged by the numerous intercostal veins which empty into it, and terminates, finally, in the superior cava vein.

The *left* or *semi-azygos*, much smaller than the preceding, begins upon the left side of the lumbar vertebræ. It receives branches from the left lumbar veins, and sometimes a small communicating branch from the left renal vein, enters the thorax beneath the internal arcuate margin of the diaphragm or through the aortic opening, and finally terminates by crossing the front of the spine transversely to reach the right azygos.

The **Thoracic Duct**, the main trunk of the lymphatic system of vessels, commences in the abdomen upon the front of the upper lumbar vertebra, behind and a little to the right of the aorta. Here the vessel is somewhat dilated into an elongated sac about the size of a small goose-quill, called the *receptacle of the chyle* (receptaculum chyli), which receives the lacteals of the digestive organs, and the lymphatics of the lower extremities, enters the thorax through the aortic opening of the diaphragm, and, continuing its course along the front of the spine, terminates eventually in the left subclavian vein.

The small size of the duct and the extreme thinness of its walls render it often difficult to find, unless it has been previously filled with solid injection.

NERVES OF THE ABDOMEN.

The Nerves of the Abdomen belong both to the organic and cerebro-spinal systems.

The Organic Nerves are either branches of the solar plexus or of the two main trunks of the sympathetic nerve.

The **Solar Plexus**, the largest of the three great plexuses of the sympathetic system, is situated upon the front of the aorta around the roots of the cœliac and superior mesenteric arteries. It is composed of numerous ganglia of various sizes, and numberless delicate nerve cords, forming an intricate network. Two of the ganglia, much larger than the others, and named from their shape the *semilunar ganglia*, are placed upon either side of the cœliac artery, and receive from the thorax the two great splanchnic nerves. From the solar plexus, multitudes of nervous filaments pass off upon the several branches of the aorta and form smaller plexuses which supply the various organs to which the arteries are distributed. The most important of these secondary plexuses are: 1, the *diaphragmatic*, a network of filaments accompanying the arteries of the same name; 2, the *suprarenal*, consisting of a minute ganglion and a few delicate offsets from the solar plexus, which enter the upper and inner part of the suprarenal capsule; 3, the *renal*, formed by numerous branches from the solar plexus and several small ganglia, which accom-

pany the artery into the substance of the kidney; 4, the *spermatic*, very small, and formed principally by branches of the renal plexus, which accompany the spermatic artery to its distribution; 5, the *superior mesenteric*, one of the largest of the secondary plexuses, consisting of a great number of filaments, including one from the pneumogastric nerve, which accompany the artery and its branches to their ultimate ramifications in the mucous membrane of the bowel; 6, the *aortic*, considered by Quain as a prolongation of the solar plexus, consisting of interlaced filaments occupying the surface of the aorta between the superior and inferior mesenteric arteries, and giving offsets to the spermatic, inferior mesenteric, and hypogastric plexuses; 7, the *inferior mesenteric*, surrounding the inferior mesenteric artery, and accompanying its branches to the large bowel; 8, the *cœliac*, properly a part of the solar plexus, surrounding the cœliac artery, and dividing with this vessel into the hepatic, coronary, and splenic plexuses, which proceed to the several organs supplied by the branches of this artery.

The two **Sympathetic Nerves** consist each of a series of connected ganglia, twenty-four or twenty-five in number, situated upon the sides of the bodies of the vertebræ, and reaching from the base of the cranium to the coccyx. The ganglia are generally small, fusiform, and of a bluish-gray or pearl color, and are named from their situation cervical, thoracic, lumbar, and sacral. The lumbar division, seen in this dissection, consists of five long spindle-shaped ganglia, situated upon the sides of the bodies of the lumbar vertebræ immediately in front of the roots of the transverse processes. They receive a few accessory filaments from the lumbar nerves as the latter emerge from the intervertebral foramina, and are all connected by an intervening small gray nervous cord.

The branches of the sympathetic nerves originate from the ganglia, and are arranged into two general divisions, an anterior and a posterior; the former follow the course of the branches of the aorta, to enter the solar plexus or the several secondary plexuses formed from it; the latter turn backward to join the spinal nerves as they emerge from the spinal canal.

The principal Spinal Nerves seen in this dissection are branches of the anterior divisions of the four upper lumbar nerves, which, emerging at their corresponding intervertebral foramina, enter the posterior part of the large psoas muscle. Here, by an interchange of fibres, they constitute the lumbar plexus, which receives also a branch from the last dorsal nerve. The branches of the Lumbar Plexus are the following:

The **Superior Musculo-cutaneous** or **Ilio-scrotal Nerve** originates from the upper part of the lumbar plexus, but is formed exclusively from the first lumbar nerve. It passes outward and downward across the superior part of the square lumbar muscle, perforates the transverse muscle,

and running forward along the crest of the ilium between the transverse and internal oblique muscles, divides into two branches, of which the *superior* and smaller is distributed to the anterior wall of the abdomen, and the *anterior* or *scrotal* branch, descending along the crural arch, accompanies the spermatic cord into the scrotum.

The **Inferior Musculo-cutaneous Nerve** originates just below the preceding, and is formed from divisions of the first and second lumbar nerves. It crosses the square lumbar and iliac muscles in the direction of the anterior superior spinous process of the ilium, and is distributed to the skin and muscles in this situation, some of its cutaneous filaments reaching as far as the pubis.

The **External Cutaneous Nerve**, a branch of the second lumbar, pierces the posterior part of the large psoas muscle, follows its external border for a little way, is then directed across the iliac muscle, passes beneath the external extremity of the crural arch, and divides into an anterior and a posterior branch, which are distributed to the skin upon the front and posterior aspect of the thigh.

The **Genito-crural Nerve** is a small filament from the second lumbar nerve. It perforates the upper part of the large psoas muscle from behind forward, and passing down upon its anterior surface as far as the crural arch, divides into a scrotal and a crural branch; the former emerges at the external inguinal ring to reach the scrotum, and the latter beneath the crural arch, to be distributed to the skin upon the inner side of the thigh. While upon the surface of the psoas muscle, this nerve is in close relation with the ureter, which is supposed to account for the pain and retraction of the testicle, in the passage of calculi from the kidney to the bladder.

The **Crural Nerve** is the largest of the branches of the lumbar plexus, and is formed from divisions of the second, third, and fourth lumbar nerves. It descends at first behind the psoas muscle, and then between its outer border and the iliac muscle, as far as the crural arch, beneath which it goes out upon the thigh and breaks up into a large number of branches.

The **Obturator Nerve**, the most inferior of the branches of the lumbar plexus, originates from the third and fourth lumbar nerves, passes along the lateral wall of the pelvis to the superior angle of the obturator foramen, through which it reaches the muscles upon the inner part of the thigh. It is accompanied by the obturator artery and vein.

The fifth lumbar, the **Lumbo-sacral Nerve**, does not properly form a part of the lumbar plexus. It emerges from the fifth lumbar intervertebral foramen, receives a branch from the fourth lumbar nerve, and descends into the pelvis over the sacro-iliac symphysis, lying close to the bones, to join the sacral plexus.

THE ABDOMINAL VISCERA.

Dissection.—Having completed the examination of the posterior wall of the abdomen, the student should proceed to the study of the viscera. These should be well washed externally without separating their attachments, the stomach and intestines slightly inflated, and the whole placed upon the table as nearly in their natural position as possible.

The Alimentary Canal, the centre of the digestive apparatus, is a long membranous tube, of different size and structure in various situations, and extending from the mouth to the anus. It consists of six principal parts, of which three are situated above, and three below the diaphragm. The parts above the diaphragm are the mouth, pharynx, and œsophagus, which will be seen in the dissection of the regions in which they are placed. The abdominal division consists of: 1, the stomach; 2, the small intestine; and 3, the large intestine.

Fig. 133.

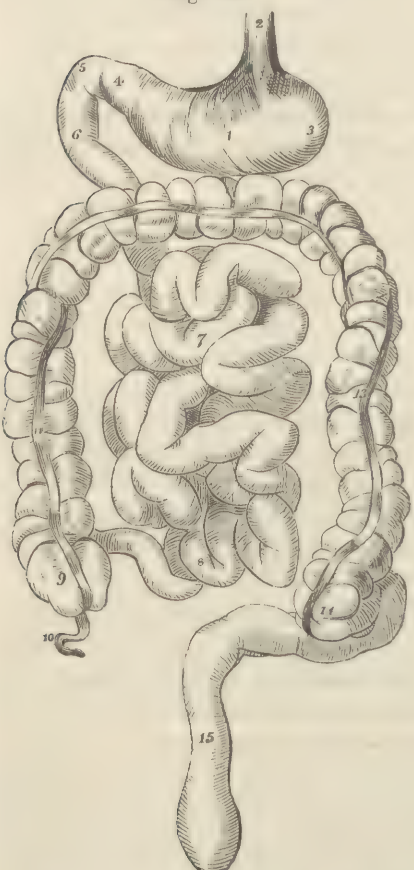

Diagram of stomach and intestines, to show their course. 1, stomach; 2, œsophagus; 3, left, and 4, right end of stomach; 5, 6, duodenum; 7, convolutions of jejunum; 8, convolutions of ileum; 9, cæcum; 10, vermiform appendage; 11, ascending, 12, transverse, and 13, descending colon; 14, commencement of sigmoid flexure; 15, rectum.

THE STOMACH.

The Stomach (Fig. 133, 1) occupies nearly the whole of the left hypochondriac and a large part of the epigastric region. It is held in its place by the œsophagus and duodenum, with which it is continuous; by the hepatico-gastric and the gastro-colic omentum; by its bloodvessels; and by the pressure of the surrounding parts. It is irregularly conoidal in shape, slightly flattened from before backward, and bent upon itself with the concavity presenting upward and to the right. When in a state of moderate distention, its axis is directed from above downward, forward, and toward the right side; but when distended to its utmost, it lies almost transversely across tho left hypochon-

driac and epigastric regions, and encroaches upon the umbilical. When entirely empty and contracted, it is not much larger than the small bowel and is contained mostly within the left hypochondriac region. These facts should be borne in mind in the diagnosis of wounds penetrating the abdominal cavity.

In the human subject, the stomach is single; and, aside from its variations in size in the same person under various circumstances, differs in actual capacity in different individuals. Sometimes it measures only a little more in diameter than the small intestine; and again, it is capable of containing one or two gallons. This difference depends in a great measure upon the different habits of eating; the organ being usually small in persons accustomed to four or five small meals a day, and large in those who take in a day's provision at a single sitting.

For convenience of description, the stomach presents an anterior and a posterior surface, a superior and an inferior border or curvature, a base or large extremity, and an apex or small extremity.

The *anterior surface* is convex, presents directly forward when the cavity is only partly full, and forward and upward when largely distended. It is in contact with the diaphragm, which separates it from the heart and base of the lungs, with the under surface of the left lobe of the liver, and to a greater or less extent with the anterior abdominal wall in the epigastric region.

The *posterior surface* looks backward and a little downward; it is in relation with the posterior wall of the abdomen and anterior surface of the pancreas, and, when the organ is distended, with the suprarenal capsule and kidney, and the transverse mesocolon.

The *base* or *large extremity* is convex, and situated deep within the left hypochondrium. It presents upward and a little outward, and is in relation with the diaphragm, which separates it from the base of the right lung, and with the concave surface of the spleen, to which it is attached by the gastro-splenic omentum.

The *small* or *pyloric extremity* lies beneath the liver in the right half of the epigastric region upon a plane somewhat anterior to the base, is turned upward, outward, and a little backward, and is continuous with the duodenum. Immediately to the left of the apex, the organ presents a slight swelling, called the *pyloric antrum*, which is analogous to the second stomach of some of the inferior animals.

The *superior border* (lesser curvature) is concave, measures from four to five inches in length, and is directed upward and backward, embracing the Spigelian lobe of the liver, and the structures upon the anterior surface of the spine. It is attached to the transverse fissure of the liver by the hepatico-gastric omentum, and has resting upon it the pyloric and gastric arteries and their accompanying veins. At the junction of the superior border and the left extremity, the stomach makes an obtuse

angle with the œsophagus. The opening between them is called the *œsophageal* or *cardiac orifice*, to distinguish it from the *pyloric orifice*, which communicates with the duodenum.

The *inferior border* (greater curvature) is convex, much longer than the superior, and in relation in the greater part of its extent with the transverse colon, to which it is attached by the gastro-colic omentum. The right and left gastro-epiploic arteries and veins pass along this border.

Vessels and Nerves.—The *arteries* of the stomach (Fig. 126) are numerous, and comparatively large: they are the gastric or coronary, pyloric branch of the hepatic, hepatico-gastric or right gastro-epiploic, splenico-gastric or left gastro-epiploic, and small recurrent branches (vasa brevia) of the splenic artery. The *veins* for the most part accompany the arteries, and terminate eventually in the portal vein. The *lymphatics* or absorbent vessels are very numerous, and enter the lymphatic glands situated along the superior and inferior borders of the organ.

The *nerves* are branches of the solar plexus and of the pneumogastric nerves, which latter enter the abdomen with the œsophagus.

The structure of the stomach will be described in connection with that of the intestines.

THE SMALL INTESTINE.

The Small Intestine (Fig. 133), comprising all that part of the alimentary canal between the stomach and the large bowel, is situated for the most part in the umbilical and hypogastric regions, and extends also into the lumbar and iliac. It has the form of a long cylindrical tube bent many times upon itself, and presents therefore a coiled or convoluted appearance. Its average length is from eighteen to twenty feet.* Its diameter is largest at its commencement or duodenal extremity, and gradually diminishes to its termination or colic extremity. For description, it is considered in three divisions, called respectively the duodenum, jejunum, and ileum.

The **Duodenum** (Figs. 133, $_{5, 6}$, and 134, $_{d}$), the first and largest portion, measures from eight to nine inches in length, and extends from the pyloric extremity of the stomach to the commencement of the jejunum, below the transverse mesocolon on the left side of the second lumbar vertebra. From its commencement it ascends toward the right and a little backward, between the two layers of the hepatico-gastric omentum to the under surface of the liver; then makes a sudden bend, and descends almost vertically; and finally turns transversely across the front of the

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* In a subject of somewhat less than medium height, the author found the small intestine not to exceed eleven or twelve feet.

spine to terminate in the jejunum. The *ascending* portion, which is the only part seen when the abdomen is first opened, is about two inches long, and lies in front and a little to the left of the neck of the gall bladder and hepatic vessels. The second or *vertical* portion is from two to three inches long, forms an acute angle with the first, and is situated in the adjacent parts of the epigastric and left hypochondriac regions, where

Fig 134.

In this figure, the liver and stomach are turned up, to show duodenum, pancreas, and spleen. *l*, under surface of liver; *g*, gall bladder; *f*, common bile duct, formed by union of duct from gall bladder, called cystic duct, and of hepatic duct coming from liver: *o*, cardiac end of stomach, where œsophagus enters; *s*, under surface of stomach; *p*, pyloric end of stomach; *d*, duodenum; *h*, head of pancreas; *t*, tail, and *i*, body of that gland; substance of pancreas is removed in front, to show pancreatic duct (*e*) and its branches; *r*, spleen; *v*, hilus, at which bloodvessels enter; *c*, pillars of diaphragm; *n*, superior mesenteric artery; *a*, aorta.

it is permanently fixed by the peritoneum, which covers only its anterior surface. It is in relation, behind, with the suprarenal capsule, the inner margin of the right kidney, and ascending cava vein; externally, with the upper part of the ascending colon; and, internally, with the head of the pancreas, and with the common bile duct, which, in connection with the pancreatic duct, perforates it below, as will be seen hereafter. The third or *transverse* portion, three or four inches in length, forms a right angle with the preceding, and is firmly inclosed between the two layers of the transverse mesocolon. It is in relation, behind, with the aorta and inferior cava, and in front with the superior mesenteric artery and vein, which cross it at a right angle.

The Jejunum (Fig. 133, $_7$) and **Ileum** (Fig. 133, $_8$). Under these names is comprised the entire length of the small bowel below the duodenum. The distinction between the two is, however, wholly arbitrary, as no natural mark of limitation exists; but to the former is assigned the upper two-fifths, and to the latter the lower three-fifths of the tube. They occupy

the umbilical and hypogastric regions, extending also into the lumbar regions, in front of the ascending and descending colon, and to a greater or less extent into the cavity of the pelvis, between the rectum and bladder. The two together measure from fifteen to twenty feet in length. Being many times folded or coiled, their direction is very tortuous, but, in a general way, oblique from the left side of the second lumbar vertebra toward the right iliac fossa. Their diameter is less than that of any other part of the alimentary canal except the œsophagus, and gradually diminishes from above downward.

The convolutions or folds of the jejunum and ileum are attached to the posterior wall of the abdomen by the mesentery, but, owing to the length of this structure, are by no means constant in their number or situation. Each one, however, may be considered as having a free convex border, presenting, generally, transversely toward the anterior wall of the abdomen, but often separated from it by the gastro-colic omentum; and a posterior or concave border, continuous by its peritoneal coat with the mesentery. The peculiar form of the mesentery and of its attachments has already been alluded to. The last coil of the ileum differs from most of the others in forming a curve with its concavity directed upward, the bowel here passing upward and toward the right, to terminate at an obtuse angle in the left wall of the colon.

Vessels and Nerves of the Small Intestine.—The *arteries* of the small intestine, with the exception of the duodenal branch of the hepatic, are branches of the superior mesenteric, which, with its accompanying vein, has been already described. The disposition of these vessels and also of the lacteals, with which the duodenum and jejunum are so numerously supplied, will be noticed in connection with the structure of the tube.

The *nerves* are branches of the mesenteric plexus, and accompany the arteries to their minute ramifications.

THE LARGE INTESTINE.

The Large Intestine (Fig. 133) commences in the right iliac region a few inches below the termination of the ileum, and ascends through the back part of the right lumbar to the right hypochondriac region; here it makes an abrupt turn, and crosses the upper part of the abdomen through the adjacent parts of the epigastric and umbilical regions to reach the left hypochondrium. At this point it makes a second bend, descends through the back part of the left lumbar and iliac regions, forming here a large fold called the sigmoid flexure, enters the pelvis, and, continuing its descent along the anterior surface of the sacrum and coccyx, terminates at the anus. Although cylindrical, it is not regularly so, but presents numerous enlargements called saccules, which are arranged in three

longitudinal rows, separated by a like number of longitudinal bands. Its length varies from five to six feet. Its size, also subject to considerable variety, is always greater than that of any other division of the alimentary canal except the stomach, but gradually diminishes from its commencement to its termination; a considerable dilatation, however, exists a few inches above the anus. Connected to its external surface are nearly always found, except in emaciated individuals, numerous little pedunculated masses of fat, which are inclosed by the peritoneum, and called the epiploic appendages.

The large intestine is divided, by anatomists, into the cæcum, with its vermiform appendage; the colon, including the sigmoid flexure; and the rectum.

The **Cæcum** (Fig. 133, $_9$), the first and largest of the three divisions, comprises all that part of the large bowel situated below the entrance of the ileum. As its name indicates, it is a blind pouch, and measures from two to four inches in length, and as many in breadth. It occupies the right iliac fossa, resting upon the iliac muscle, from which it is separated by the iliac fascia, and is directed obliquely from below upward and outward, forming an obtuse angle with the colon. It is held in its position by the peritoneum, which covers only its anterior and lateral surfaces, and is in relation, in front, with the anterior abdominal wall, internally with the lower end of the ileum, and posteriorly with the iliac fascia.

Connected to the lower internal wall of the cæcum, and communicating with its cavity, is the *Vermiform Appendage*, a blind membranous tube about the size of a large goosequill, and from four to five inches in length. It is generally found coiled up in a fold of the peritoneum upon the surface of the iliac fascia, or upon the inner aspect of the cæcum.

The **Colon** (Fig. 133, $_{11,12,13}$) consists of ascending, transverse, and descending portions.

The *ascending colon* extends from the cæcum to the transverse colon, traversing the back part of the right lumbar region, and forming a curve with its concavity presenting forward. It is held in its position by the peritoneum, which covers only its lateral and anterior surfaces, and is in relation anteriorly with the small intestine, and posteriorly with the square lumbar muscle and right kidney, to each of which it is connected by areolar tissue, the peritoneal investment being here deficient.

The *transverse colon*, or, as it is sometimes called, the *arch* of the colon, is intermediate in size and position to the ascending and descending divisions. In its course across the abdomen it forms a curve whose convexity presents forward, and gives attachment to the gastro-colic omentum, and is in contact with the anterior wall of the abdomen, along the adjacent borders of the epigastric and umbilical regions. Its pos-

terior or concave surface is in relation with the transverse portion of the duodenum, and is attached to the posterior abdominal wall by a very broad mesocolon, which forms a septum between the upper third and lower two-thirds of the abdomen. Its right extremity is in contact with the under surface of the anterior border of the right lobe of the liver, and the fundus of the gall bladder; its left extremity is in relation with the lower extremity of the spleen, to which it is often found attached.

The *descending colon* passes from the left hypochondrium, through the back part of the left lumbar to the left iliac region, where it turns back upon itself to form the sigmoid flexure. It is much longer and smaller than the ascending division, and, like it, has immediate relations with the kidney and square lumbar muscle.

The *sigmoid flexure* (Fig. 133, $_{14}$) varies in extent in different individuals, and, being attached by a remarkably long mesocolon, is often found thrown over into the umbilical region, or even into the pelvis; this latter displacement is most apt to occur when there is large fecal accumulation in this part of the bowel.

The **Rectum** (Fig. 133, $_{15}$), the last division of the large intestine, commences opposite the left sacro-iliac symphysis; it descends at first a little to the right to gain the median line, and then directly downward, following the concavity of the sacrum and coccyx, to which it is attached in the upper part of its course, by a fold of the peritoneum called the mesorectum. Its lower extremity, to the extent of two or three inches, is deficient in peritoneal investment, this membrane leaving the anterior surface of the bowel, to reach the back part of the bladder in the male, and the vagina in the female. The rectum does not present the sacculated arrangement observed in the rest of the large bowel, but just above its termination is marked by a considerable dilatation called the rectal pouch. Its relations with the pelvic viscera will be noticed in the dissection of these organs.

Vessels and Nerves of the Large Intestine.—The *arteries* of the large intestine are branches of the superior and inferior mesenteric, excepting the middle and inferior hemorrhoidal arteries, which come from the inferior vesical and internal pudic, and supply the lower part of the rectum. The *veins* form a part of the portal system, but the hemorrhoidal communicate also with the internal iliac. The *lymphatics* are numerous, and enter the lymphatic glands along the attached border of the mesocolon, and thence continue to the thoracic duct.

The *nerves*, with the exception of those distributed to the lower part of the rectum which belong to the cerebro-spinal system, are subdivisions of the solar plexus.

STRUCTURE OF THE STOMACH AND INTESTINES.

The Stomach and Bowels are composed of four separate layers or coats, placed one within the other, and continuous throughout the whole length of the canal. They are, commencing with the external, the serous, muscular, areolar, and mucous.

The **Serous Coat** is derived from the peritoneum, which, as already seen, invests no part of the tube completely, and in some places is wanting to a considerable extent. On the stomach, it is deficient along a narrow space upon the superior and inferior borders, where the two layers of the omenta separate. On the first part of the duodenum, it is arranged as upon the stomach; on the second, or vertical portion, it exists only upon the anterior surface; and on the third, or transverse division, it covers the superior and inferior surfaces. It almost completely invests the jejunum and ileum, being deficient only along the narrow attachment of the mesentery. On the large bowel, as already described, it varies in its extent at different parts, and is entirely wanting at the lower part of the rectum. (See Fig. 125.)

The serous coat assists in giving strength to the canal, and furnishes a smooth surface for the several organs to glide upon one another and upon the surrounding structures. Although possessing little elasticity, it allows great dilatation of the hollow viscera by the separation of its reflected layers.

The **Muscular Coat** may be seen by dissecting off the preceding, or by simply holding a piece of the stomach or bowel between the eye and the light. Its fibres belong to the organic or unstriped variety, and are somewhat differently arranged in the different divisions of the canal.

On the Stomach.—The muscular tunic of the stomach is quite thin upon the great end of the organ, but increases in thickness as we approach the pyloric extremity. It consists of three sets of fibres, named, from their direction in reference to the axis of the organ, the longitudinal, circular, and oblique. The *longitudinal fibres* are continuations of the longitudinal fibres of the œsophagus, and spread out over the organ in the direction of its pyloric extremity. They are few and scattered upon the anterior and posterior surfaces, more numerous in the neighborhood of the pylorus, and collected into a well-marked band along the superior and inferior borders or curvatures. The *circular fibres* embrace the organ transversely, forming right angles with the preceding, beneath which they are situated. They are few and indistinct upon the left extremity, numerous and well developed in the middle and right extremity, and, where the stomach joins the duodenum, are collected into a distinct annular bundle, forming a true sphincter muscle, by the contraction of which the pyloric

orifice may be entirely closed. The *oblique fibres* exist only on the left or great extremity. They are not very numerous, and extend from above obliquely downward upon the anterior and posterior surfaces, where they gradually disappear.

On the Small Intestine.—The muscular fibres of this division of the tube are longitudinal and circular, the latter situated within the former. The *longitudinal fibres* are few and scattered, except along the posterior border of the intestine where they are collected into a band; no single fibre, however, exceeds a few inches in length. The *circular fibres* are very numerous, and form a continuous layer from the pylorus to the termination of the ileum. They are most abundant in the jejunum, and it will be noticed that each fibre stops short of a complete ring, or that its extremities pass by each other.

On the Large Intestine.—Here also there are longitudinal and circular fibres, but they are arranged differently from the preceding. The *longitudinal fibres* are collected into three flattened bands, which are nearly equidistant, and extend from the cæcum to the rectum. These bands are considerably shorter than the intervening walls of the bowel, and thus give rise to the sacculated form of this part of the tube, as may be proved by dividing them at various points, when the saccules will be found to disappear, and the length of the bowel to be materially increased. The *circular fibres* pass transversely between the longitudinal bands, and are very thinly scattered over the convexities of the saccules, but in the intervening spaces they are collected into small bundles, which project internally to form the intersaccular septa.

In the rectum, as before mentioned, the longitudinal fibres are not collected into bands, but spread out upon the whole circumference of the intestine. The circular fibres increase in number from above, and at the anal extremity of the canal form a distinct band of considerable size, called the *internal sphincter muscle*, which contains also a few voluntary or striated fibres; the muscle controlling the contraction of the anus being called the *external sphincter*.

The **Areolar** or **Fibrous Coat** is situated between the muscular and mucous layers, and may be satisfactorily exhibited in the following manner:

Dissection.—Take a section of small intestine, six or eight inches in length, free it from mesentery, make a few short incisions through the serous and muscular layers, and then, having turned it inside out, tie up one end and inflate it forcibly through the other. In this manner, the air is made to enter through the incisions and distend the interstices of the areolar coat, being prevented from escaping externally by the mucous membrane. If the piece of intestine be dried in its inflated condition, the mucous membrane may be afterward stripped off, leaving the areolar coat in the form of a beautiful white flocculent cylinder, supported underneath by the muscular and serous layers.

This was formerly called, from its whiteness, the nervous coat, and more recently the submucous areolar tissue. It is found throughout the whole

intestinal canal, but varies in its density and strength in different situations, being thickest in the stomach and least developed in the large intestine; and, as will be hereafter mentioned, appears to be almost entirely wanting beneath the elliptical patches of the ileum. It is to this coat that the strength of the walls of the canal is mainly due. It forms, in fact, the framework of the tube, serving at the same time as a bond of union between the mucous and muscular layers. It is in this coat also that the arteries divide minutely before entering the mucous membrane, and the radicles of the veins and lymphatics ramify in it before uniting to form larger trunks, so that, when these several sets of vessels are injected with colored fluid, it appears more like a vascular than a fibrous structure.

The **Mucous Membrane** lining the alimentary canal extends from the mouth to the anus; but distant as these two points are they by no means limit its distribution. It is prolonged into all the cavities and ducts communicating with the canal, and, as will be presently seen, is arranged in certain situations into permanent folds, by which its extent is largely increased.* That portion now under consideration, called the gastro-intestinal mucous membrane, should be studied separately in the stomach, small intestine, and large intestine.

Dissection.—For this purpose, the stomach should be separated by dividing the duodenum two or three inches beyond the pylorus, and then laid open by an incision along its superior curvature, and well washed under a stream of water. The small intestine should then be severed from the mesentery, cut off within three or four inches of its cæcal termination. everted or laid open by an incision along its mesenteric border, and thoroughly cleansed. The large bowel should be treated much in the same manner, dividing it a few inches above the termination of the ileum, in order to allow the study of the ileo-cæcal orifice.

In the Stomach.—The gastric mucous membrane in a perfectly healthy individual is of a pinkish-gray color, the degree of the pink hue varying according to the state of digestion, being greatest shortly after the introduction of food, and least during the quiescent state of the organ. In ordinary examinations, however, this healthy color is rarely met with, even in persons who manifested no gastric disease during life, on account of the rapid changes which the membrane undergoes after death. Hence it is not uncommon to find brown or black patches along the inferior curvature, or streaks of black over the course of the large veins, and frequently a pale tumid appearance from the collection of fluid in the cellular coat; changes that are apt to deceive students and others who are not well acquainted with *post-mortem* appearances. Its thickness depends very much upon the same circumstances that influence its color, but in general is greatest in the neighborhood of the pyloric extremity and along the inferior curvature.

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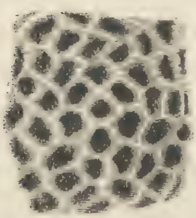
* For an account of the structure and distributions of mucous membranes in general, see page 83.

When the stomach is empty and contracted, the mucous lining presents numerous folds or rugæ, which are mostly longitudinal and situated along the inferior curvature; but they are all effaced when the organ is distended. At the pyloric extremity, however, there is a permanent fold called the *pyloric valve*, which is annular and nearly half an inch in breadth, and has a gastric and a duodenal surface, and a sharp free edge, which defines the opening (pyloric orifice) between the stomach and duodenum. The valve is composed not only of mucous membrane but of muscular fibres, by the contraction of which the opening may be entirely closed.

The mucous membrane of the stomach is covered by columnar epithelium, and, if examined with a simple lens, its free surface will be found traversed in every direction by numerous slightly-raised ridges which inclose polygonal depressions called *alveoli* (Fig. 135). These depressions are particularly well seen in the pyloric extremity of the organ, where they measure about $\frac{1}{150}$ of an inch in diameter, and are dotted all over by the minute orifices of the gastric glands.

Fig. 135.

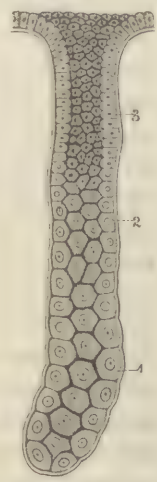


Gastric pits. Inner surface of stomach, from which mucus has been washed to show honeycomb appearance of mucous membrane.

Fig. 136.

Small portion of mucous membrane of stomach, with imbedded gastric glands. 1, glands; 2, orifices of glands; 3, epithelium of mucous membrane; moderately magnified.

Fig. 137.



Gastric gland, highly magnified. 1, large nucleated cells at bottom of gland, gradually merging 2 into the columnar cells 3, at upper part of gland.

The *Gastric Glands* (Figs. 136 and 137) are tubular, closely set, parallel with each other, and perpendicular to the surface. They vary in length from $\frac{1}{20}$ to $\frac{1}{60}$ of an inch, according to the thickness of the mucous membrane, being longer therefore in the pyloric than in the cardiac extremity of the organ. They are lined by an inversion of the columnar epithelium, the cells of which, however, are said to assume a rounded polyhedral form in the deeper part of the tube.* They are doubtless the organs from which the gastric fluid is secreted.

* Leidy.

In addition to the tubular glands, follicles of the racemose variety are found throughout the gastric mucous membrane, especially in the neighborhood of the pylorus, but they are comparatively few in number.

The continuation of the pavement epithelium of the œsophagus with the columnar of the stomach at the cardiac orifice takes place abruptly, forming a festooned line, which in a perfectly fresh specimen may be sometimes seen with the naked eye.

In the Small Intestine.—The mucous membrane of the small bowel, like that of the stomach, is covered by a columnar epithelium. It is much thicker and more vascular in the duodenum and jejunum than in the ileum, and marked by the following characteristics: 1. It presents numerous permanent folds called valvulæ conniventes. 2. Its surface is studded with numberless little processes termed villi. 3. Imbedded in its structure are numerous glands, of which three distinct varieties are recognized.

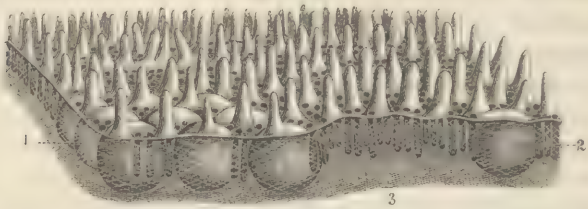
The *Valvulæ Conniventes* are horizontal folds which exist throughout nearly the whole extent of the small intestine, and, unlike the rugæ observed in the stomach, are not effaced by distending the tube. They are wanting in the first division of the duodenum, but, commencing in the vertical division near the entrance of the pancreatic and biliary ducts as slight ridges, they increase rapidly in size and number from above downward, and in the lower part of the duodenum and upper part of the jejunum they are so broad and so closely packed as nearly to overlap each other. They do not, however, form complete rings, but generally extend about two-thirds the circumference of the bowel, and, from the points just indicated, they gradually diminish in size, become less closely set, and finally subside entirely within a few feet of the termination of the ileum. Their use seems to be to increase the extent of the secreting and absorbing surface, and as they doubtless undergo a kind of erection during digestion by the distention of their bloodvessels, they serve also to retard the passage of the food, and thus subject it to the prolonged action of the absorbents.

The *Villi* (Figs. 138 and 139) are delicate little prolongations of the mucous membrane, which, being very closely set, give to its surface a peculiar velvety appearance. They may be readily seen with the naked eye by immersing a piece of bowel in clear water; and, when examined with a glass of moderate power, will be found to vary in number, shape, and size in different situations. They are most numerous in the lower part of the duodenum and upper third of the jejunum, are much more scattered in the ileum, and are said to be entirely wanting in the first half of the duodenum.* Where they are thickest they have the form of delicate folds or leaves, but in the ileum they are more conical or hair-

* Carpenter.

like, and measure about $\frac{1}{4}$ of a line in length. They are found upon no other mucous membrane in the body. Considered as a separate structure,

Fig. 138.



Portion of mucous membrane from ileum, moderately magnified, exhibiting villi on its free surface, and between them orifices of tubular glands. 1, portion of agminated gland; 2, solitary gland; 3, fibrous tissue.

each villus consists of a prolongation of the proper mucous tissue covered by its epithelium, and contains the ramifications of an arterial twig, the

Fig. 139.

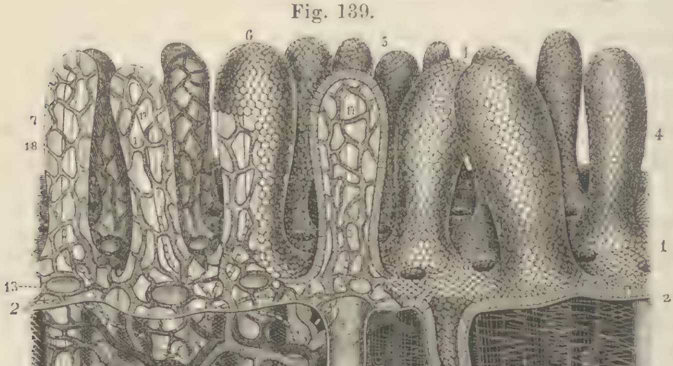


Diagram of structure of mucous membrane of ileum, highly magnified. 1, epithelium forming free surface of mucous membrane; 2, basement membrane; 3, fibrous layer; 4, villi covered with epithelium; 5, villus deprived of one-half of its epithelium, and exhibiting through its basement layer bloodvessels; 6, villus partially deprived of its epithelium; 7, villi totally deprived of their epithelium, but retaining their basement membrane; 8, tubular glands imbedded in fibrous layer of mucous membrane; 9, orifices of tubular glands opening on free surface of mucous membrane between villi; 10, section of tubular gland, with its epithelial lining; 11 tubular glands stripped of latter, but retaining their basement membrane; 12, gland in section, without its epithelium; 13, capillaries surrounding orifices of tubular glands; 14, artery; 15, vein; 16, lymphatics or lacteals; 17, commencement of latter within villi; 18, capillary bloodvessels of villi.

radicles of a small vein, the commencement of a lacteal vessel, and, in all probability, one or more ultimate nervous filaments. The precise arrangement of these vessels, however, has not been accurately ascertained. But,

in regard to the lacteal, it has been established that this vessel, which was at one time supposed to commence upon the extremity of the villus by an open mouth, consists of one or more minute blind radicles, which ramify beneath the epithelium, and form a single trunk at the base of the villus.

The Glands of the small intestine are the duodenal, tubular, solitary, and agminated, the last two belonging to the same class.

The *Duodenal Glands*, called also the glands of Brunner, are found only in the upper part of the duodenum, and are most numerous immediately below the pyloric valve, where they are closely impacted in the submucous areolar tissue. They are about the size of a No. 6 shot, of a pale pinkish color, and have a granular or lobular outline. They belong to the class of racemose glands, and open by distinct ducts upon the free surface of the membrane. Their secretion bears a very close resemblance to that of the pancreas and the salivary glands, but its special use is not known.

The *Tubular Glands* (Figs. 138 and 139) or the crypts of Lieberkühn do not differ in appearance from the gastric glands, but are less numerous in a given space, and therefore not so closely arranged. They are lined by a prolongation of the columnar epithelium and open upon the free surface of the mucous membrane between the villi. They secrete the intestinal juice, but whether this fluid is intended simply to keep the membrane moist or to assist in digestion, physiologists have not determined.

The *Solitary Glands* (Fig. 138) are scattered throughout all parts of the small intestine, but except when enlarged by disease cannot be readily detected without a magnifying-glass. They are small, rounded, whitish-looking bodies imbedded in the thickness of the mucous membrane, upon the surface of which they form a slight elevation. They have no excretory duct, but consist of a thin fibrous capsule inclosing an opaque fluid abounding in nucleated cells, free nuclei, and granules. Their function is unknown.

The *Agminated Glands*, or, as they are commonly called, the glands of Peyer, do not differ from the solitary, except in their arrangement into groups. They are situated for the most part in the lower third of the small bowel, and are collected into oval or elliptical patches, varying in size from about half an inch or even less, to three or four inches in length. They vary in number from twenty to forty, although in a single instance the author counted as many as fifty-four. They are found only along the free border of the intestine (*i.e.* opposite the mesenteric attachment), at the distance of a few inches or a foot or more from each other, becoming smaller and more scattered from below upward, and disappearing entirely some distance below the duodenum. When not altered by disease, they are frequently difficult of detection, but, guided by the

fact that they are generally somewhat depressed below the surrounding surface, and not crossed by the transverse folds (valvulæ conniventes), the student will always be able to find them.

Fig. 140.

Patch of Peyers's glands, natural size.

The surface of each patch presents a faintly lobulated appearance, is covered with villi, and between these latter may be seen the orifices of numerous tubular glands. Being frequently the seat of inflammation and ulceration in typhoid fever, they are objects of great interest to pathologists, but nothing is positively known of their function.

In the Large Intestine.—The mucous membrane of the large bowel is paler and thinner than that of any other part of the alimentary canal, and much more simple in structure than the preceding. It unites with the other coats in forming the three rows of pouches or sacculi and their intervening septa heretofore described, but presents no independent folds like the valvulæ conniventes. It is entirely destitute of villi, but contains a large number of tubular glands and a few solitary follicles. The structure of the vermiform appendage does not differ materially from that of the large bowel.

Fig. 141.

Mode of opening of ileum into cæcum and colon. *a*, terminal part of ileum; *b*, ileo-cæcal valve; *c*, cæcum; *d*, vermiform appendage; *e*, commencement of colon.

The student should now examine the *Ileo-cæcal Valve*, the opening of communication between the ileum and large bowel, which may be done upon the dried preparation or upon the fresh specimen suspended in water.

The termination of the ileum is situated upon the inner wall of the large bowel at the junction of the cæcum and colon. When examined from within, it is found to consist of two horizontal prominent lips, and an intervening

transverse slit like a buttonhole, about three-fourths of an inch in length. The lips, of which the superior is much the broader, are composed of the mucous membrane, areolar coat, and muscular fibres, which are continued outward from the angles of the valve in the form of two small horizontal folds.

The mechanism of the valve is somewhat like that of a folding door. In the passage of matters from the ileum the lips separate by being pressed upon from that direction, but if the pressure is made from the opposite side, which may be imitated upon the dead subject by the injection of air or fluid into the large bowel, the lips are approximated and the opening closed, and the greater the distention of the large bowel the more close will be the approximation, owing to the traction of the little folds connected to the angles. During life the contraction of the muscular fibres doubtless assists the closure.

The mucous membrane of the rectum is thicker and of a much redder color than in the other divisions of the large intestine, especially in its lower part. It is comparatively loosely attached to the subjacent structures, and when the bowel is empty presents near its lower termination numerous longitudinal folds, which, however, are all obliterated by distention. There also exist in some cases two or three transverse crescentic folds of a permanent character, which are liable to become much elongated by the lodgment of hardened feces above them, and occasionally so obstruct the passage of the latter as to require division by the surgeon. They are not found, however, in the majority of subjects, and when present are not uniform in their situation, although, when they exist, one may generally be observed upon the anterior wall about two inches from the anus.

THE LIVER.

Dissection.—Detach the liver from the other viscera by dividing the hepatic artery, portal vein, and common bile duct, turn it upon its upper surface, and dissect apart the three vessels just mentioned as they enter the transverse fissure upon its under surface.

The Liver is the largest secreting gland in the body, and weighs more than all the others combined. It is situated in the upper part of the abdomen, occupying nearly the whole of the right hypochondriac and the superior part of the epigastric regions, and often a portion of the left hypochondrium. It is held in its position principally by reflections of the peritoneum, but is not, however, perfectly stationary, being depressed by the diaphragm in inspiration, and somewhat by its own weight in the different postures of the body. It is semi-ovoidal, with its long diameter transverse, and is much thicker at its right than at its left extremity. It is liable to great variety in size, weight, and shape, but in general it meas-

ures from ten to twelve inches in length, six or seven in breadth, and three to four in thickness at its thickest part, and weighs about four pounds. It is not unusual, however, to find both the breadth and length to be about nine or ten inches or much less; and its weight may not exceed two and a half, or fall short of six pounds, within the bounds of health. As a general rule, it is larger in the male than in the female, and, in proportion to the size of the body, very much larger in the fœtus, and immediately after birth, than at any other period of life. It is of a reddish-brown color, lighter in some cases than in others, but generally dark, and not unfrequently of an olive green or bluish hue, especially upon its under surface.

External Characters of the Liver.—It has a superior and an inferior surface, an anterior and a posterior border, and a right and a left extremity.

The *Superior Surface*, when the organ is in its place, presents somewhat forward as well as upward. It is smooth and convex, and is traversed from before backward near its left extremity, and in the median line of the body, by the attachment of the suspensory ligament; it is in accurate apposition with the concavity of the diaphragm, which separates it from the right lung and heart.

The *Inferior Surface* looks downward and a little backward, is irregularly concave, and marked by numerous depressions, the most remarkable of which are the longitudinal and transverse fissures, the groove for the inferior cava, the fossa for the gall bladder, and a slight excavation corresponding to the right kidney.

The *longitudinal fissure* lies directly opposite the attachment of the suspensory ligament, and extends from the anterior to the posterier border, thus dividing the organ unequally into a right and left lobe. Its anterior half forms a deep notch in the anterior border, lodges the remains of the umbilical vein, and is sometimes converted into a canal by a bridgelike prolongation of the hepatic substance. The posterior half, less deep than the anterior, is occupied by a little band of areolar tissue representing the venous duct of the fœtus.

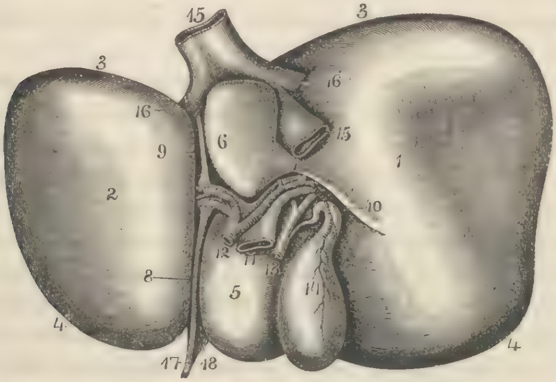
The *transverse fissure* is situated upon the under surface of the right lobe in the direction of the long axis of the organ, and joins the preceding at a right angle a little beyond its middle. It is from one and a half to two inches in length, quite deep, and transmits the portal vein, and hepatic artery, duct, and nerves.

The *groove for the inferior cava* is a short distance to the right of the posterior half of the longitudinal fissure; it is directed from the posterior border obliquely forward upon the under surface to the distance of an inch or more, and is occupied by the inferior cava, which here receives

the hepatic veins, and is so closely attached to the substance of the organ that it is difficult to dissect it off.

The *fossa for the gall bladder* is a shallow excavation in front of the right extremity of the transverse fissure, from which point it extends to the anterior border of the organ. The gall bladder is here attached by a continuation of the peritoneum over its lower surface, and by intervening areolar tissue, but may be easily lifted out of its bed without injury by careful dissection.

Fig. 142.



Inferior surface of liver. 1, right lobe; 2, left lobe; 3, posterior margin; 4, anterior margin; 5, quadrate lobe; 6, caudate lobe; 7, isthmus, or caudate process, connecting latter with right lobe; 8, 9, longitudinal fissure; 10, transverse fissure; 11, portal vein; 12, hepatic artery; 13, common biliary duct formed by union of hepatic and cystic ducts; 14, gall bladder; 15, inferior cava; 16, hepatic veins; 17, round ligament; 18, anterior part of suspensory ligament.

Still farther to the right the surface presents a broad superficial depression corresponding to the upper extremity of the right kidney and suprarenal capsule.

By means of the transverse fissure the liver is divided, as already seen, into a right and left lobe. The *right lobe* comprises about five-sixths of the organ, occupies the right hypochondriac and right half of the epigastric region, and is subdivided upon its under surface into the Spigelian, caudate, and square lobes. The *left lobe* varies exceedingly in size in different individuals, is situated in the left half of the epigastric region, encroaching more or less upon the left hypochondriac, and rests by its inferior concave surface upon the anterior surface of the stomach.

The *Spigelian lobe* (lobulus Spigelii) is a small but very prominent quadrangular eminence lying behind the transverse fissure, and between the furrow for the inferior cava and the posterior half of the longitudinal fissure. Its two lateral surfaces are abrupt, and the right somewhat ex-

cavated by the groove for the cava; the inferior is smooth and slightly convex; its posterior extremity or apex is but slightly raised above the surrounding parts; the anterior extremity or base, constituting the prominent posterior margin of the transverse fissure, is in relation with the portal vein and smaller curvature of the stomach, and runs off along the posterior border of the transvere fissure in the form of a tail-like prolongation, called the *caudate lobe* (lobulus caudatus).

The *square lobe* (lobulus quadratus) is a quadrangular space situated in front of the transverse fissure and between the gall bladder and the anterior half of the longitudinal fissure. It is but slightly raised above the general level and is in contact by its free surface with the pyloric extremity of the stomach.

The *Posterior Border* of the liver is thick and rounded, and notched for the reception of the spine and the great vessels lying in front of it. On each side, it is in contact with the diaphragm, to which it is attached by the reflections of the peritoneum which form the lateral ligaments of the organ, and by intervening areolar tissue. The *Anterior Border* is thin and sinuous, and marked by two notches, one of which corresponds to the anterior extremity of the longitudinal fissure and lodges the remains of the umbilical vein, and the other to the fundus of the gall bladder. To the right of the notch for the umbilical vein it is in relation with the inferior margin, the thorax, and the transverse colon; and, on the left, it lies between the stomach and the diaphragm. The *Right Extremity* presents a thick rounded border behind, becomes narrow in front, and is in close contact with the diaphragm nearly as far as the anterior border. The *Left Extremity* forms a thin sharp lip, usually resting upon the anterior surface of the great end of the stomach, but not unfrequently in contact with the superior extremity of the spleen.

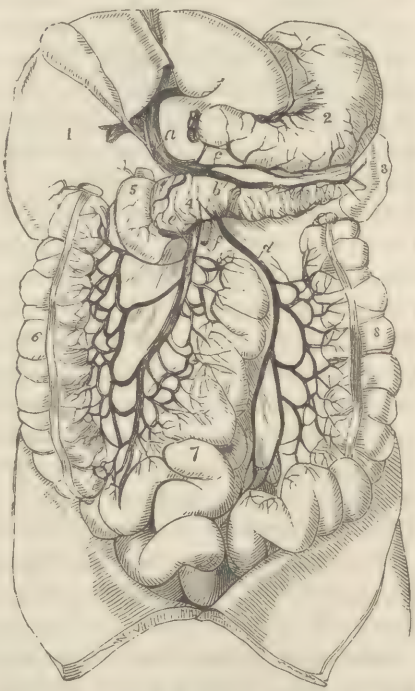
The liver receives an almost complete covering from the peritoneum, which is deficient only along the posterior border, at the bottom of the fissures, and beneath the gall bladder. The membrane is closely but not very firmly attached to the proper tissue of the organ, and is apparently continuous by its under surface with the constituent fibrous tissue, called the capsule of Glisson, which penetrates the latter in every direction.

Ligaments of the Liver.—The liver is held in its position by the peritoneum, whose reflections are here called ligaments; of these, there are properly but three, the two lateral and the suspensory or falciform. The *right lateral ligament* is the continuation of the peritoneum from the under surface of the diaphragm to the posterior border of the right lobe; it is very short and strong, and consists of two layers, which, however, are separated from each other nearly the entire thickness of the border, the intervening space being connected to the diaphragm by areolar tissue.

The *left lateral ligament* connects the posterior border of the left lobe to the diaphragm; it is longer than the preceding, and its two layers are in contact. The *suspensory ligament* is formed by a continuation of the anterior layer of the lateral ligaments. It is attached, on the one hand, to the superior surface of the liver, opposite the division between the right and left lobes, and, on the other, to the middle line of the anterior part of the diaphragm, and to the middle line of the anterior abdominal wall, reaching as far as the umbilicus. Its inferior margin incloses the fibrous remains of the umbilical vein, which is sometimes called the *round ligament.*

Vessels and Nerves of the Liver.—The vessels which enter the liver are the portal vein and hepatic artery; and those coming from it are the hepatic duct, lymphatics, and hepatic veins. All, with the exception of the veins, which emerge in the groove for the inferior cava, are found within the transverse fissure, and should be drawn out with a tenaculum and dissected separately, in order to be seen to advantage.

Fig. 143.



View of vessels of the portal system. 1, liver; 2, stomach; 3, spleen; 4, pancreas; 5, vertical portion of duodenum, ascending portion cut away; 6, ascending colon, transverse colon removed; 7, small intestine; 8, descending colon. *a*, main trunk of portal vein; *b*, splenic vein; *c*, gastric vein; *d*, inferior mesenteric vein; *e*, superior mesenteric vein; *f*, superior mesenteric artery, cut.

The *Hepatic Artery* has been already described. It is a branch of the cœliac, passes upward between the layers of the hepatico-gastric omentum, enters the transverse fissure with the portal vein behind, and the hepatic duct in front and upon the right, and ramifies throughout the organ, always in company with these two vessels.

The *Portal Vein* is four or five times the size of the hepatic artery, and is formed by the superior mesenteric and splenic veins, which unite at a right angle behind the right extremity of the pancreas. From this point the vessel ascends, inclining a little to the right, enters the hepatico-gastric omentum, and, having reached the transverse fissure of the liver, divides into a

right and left branch, which, penetrating the respective lobes of that organ, subdivide and ramify through its substance in company with the branches of the hepatic artery and duct.

It will be understood then that the portal vein, by means of the mesenteric and splenic veins and their communicating branches, receives all the venous blood from the stomach, small intestine, large intestine, spleen, and pancreas, and circulates it through the liver. But the student must bear in mind that this differs from venous blood in every other part of the body, for it contains, in addition to the ordinary constituents, the various substances that have been absorbed from the stomach and bowels, and a large part of it has also undergone certain unknown changes by its passage through the spleen.

The *Hepatic Veins* open by two or three very large and several smaller patulous mouths into the inferior cava at the posterior border of the liver. They ramify through the organ separate from the hepatic artery and portal vein, and as their general direction is from the circumference toward the middle line behind, and that of the latter from the middle of the lower surface toward the circumference, the two sets cross each other nearly at right angles. A longitudinal section of the organ will therefore exhibit more cut extremities of hepatic veins, and a transverse section more portal veins and hepatic arteries.

It will be thus seen that the blood that is carried to the liver by the portal vein and hepatic artery is all ultimately collected by the hepatic veins, and poured into the inferior cava, where it mingles with the general circulation. But in its passage through the liver it has undergone great changes; for not only has it nourished the organ, and furnished the materials for the secretion of bile, but from it has also been formed sugar, first deposited in the tissue of the liver as amyloid matter, glycogene, and then converted into sugar, which passes into the blood.

The *Hepatic Duct* lies in front of the hepatic artery, but its description belongs more properly to that of the Excretory Apparatus of the Liver (p. 287).

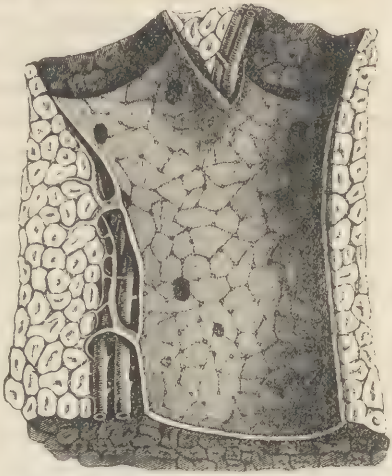
The *Hepatic Nerves* are derived principally from the solar plexus, a few filaments coming also from the pneumogastric. They are very small, but numerous, and enter the organ supported by the walls of the vessels, particularly the artery, around which they form an intricate network, known as the *hepatic plexus.*

The *Lymphatics* are very numerous and comparatively large. They leave the organ not only at the transverse fissure, but also along the posterior border, and enter the neighboring lymphatic glands.

Structure of the Liver.—If the substance of the liver be torn with the fingers, the torn surface will present, even to the naked eye, number-

less small granules, held together by delicate layers of fibrous tissue and minute vessels. The granular bodies are termed acini or lobules, and the intervening fibrous tissue is the capsule of Glisson.

Fig. 144.



Portion of liver of hog, exhibiting lobular structure; large vessel is branch of portal vein, outlines of lobules being seen through its transparent wall; orifices, large and small, seen in portal vein, are fine branches sent between lobules. Two vessels lying to left of portal vein are branches of hepatic artery and duct.

The *Capsule of Glisson* is the framework of the liver, and consists of areolar or fibrous tissue, which forms a thin investment for the entire organ, and by its prolongations internally forms interstices in which are lodged the acini. It serves, therefore, not only as a bond of connection between the peritoneum and the liver, and between the individual acini, but also as a nidus for the ramifications and anastomoses of the vessels. It varies in its density in different situations, being short and close around the branches of the hepatic veins, but is more loose in its texture around the three associated vessels, namely, the portal vein, hepatic artery, and hepatic duct, so that when the organ is incised, the cut extremities of the former remain widely open, while those of the branches of the portal vein usually collapse.

The *Acini* or lobules constitute the proper hepatic tissue. They are of a dark reddish-brown color, polyhedral, and measure from half a line to a line in diameter. They are composed of an interlacement of bloodvessels and hepatic ducts, and of peculiar cells called hepatic cells, but the precise relations of these to each other is not satisfactorily determined. What is positively known in regard to the matter may be stated in few words.

Each lobule rests in contact, by one side only, with a branch of the hepatic vein, and is surrounded upon all its other sides by an intricate plexus of minute vessels coming from the portal vein and hepatic artery, the plexus being, in all probability, common to the two. From this vascular net capillary vessels are given off which penetrate the lobule in every direction, and terminate in its interior in the radicles of the hepatic veins. The latter, therefore, begin in the substance of the lobule, and uniting together form a single venule, which opens immediately into the intralobular hepatic vein upon which the lobule rests.

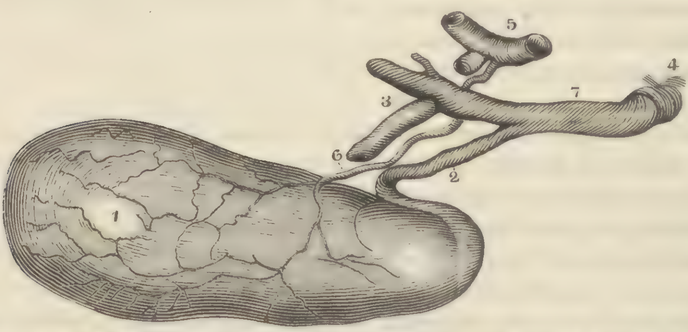
The hepatic ducts likewise form a network upon the exterior of the lobule, penetrate the latter upon all sides, and form within its substance a plexus which is intertwined with the interlobular bloodvessels, but has, of course, no communication with them.

The hepatic cells are probably the true secreting tissue of the liver. They are polyhedral, vary in size from $\frac{1}{2000}$ to $\frac{1}{1000}$ of an inch in diameter, and contain a nucleus, granular matter, and not unfrequently oil globules. Their exact situation, whether in the interstices of the vessels or upon the inner wall of the interlobular hepatic ducts, is a disputed question, but the latter is the more plausible theory.

The Excretory Apparatus of the Liver.—This consists of the gall bladder, cystic, hepatic, and common bile ducts.

The *Gall Bladder* is a pyriform membranous sac, of variable size, measuring usually from three to four inches in length, and one inch in breadth at its widest part, and capable of containing about an ounce of

Fig. 145.



Gall bladder and ducts. 1, gall bladder; 2, cystic duct; 3, hepatic duct; 7, common bile duct; 4, its termination in duodenum; 5, hepatic artery; 6, cystic artery.

fluid. It is situated in a shallow fossa upon the under surface of the right lobe of the liver, to which it is attached by areolar tissue, and by the peritoneum, which is reflected off on each side. It is in relation below with the ascending portion of the duodenum and right extremity of the transverse colon. Its *fundus* or bottom usually projects a few lines beyond the anterior margin of the liver, and is in contact with the anterior abdominal wall, near the cartilage of the tenth rib. Its *neck* is formed by the gradual narrowing of the body behind, and is remarkable for its curved direction, which is correctly represented by the italic letter *f*.

The walls of the gall bladder are composed of three coats, one partial and two complete. The *external* or *partial coat* is serous, and derived from the peritoneum, which invests the lower half or two-thirds of the sac, and is reflected off on each side to the under surface of the liver. The *middle coat* is composed of condensed areolar tissue, intermingled

with the fibres of which non-striated muscular fibres are found to exist in greater or less abundance in different animals, being comparatively few in the human subject, but so numerous in the ox as to constitute almost a separate tunic. The *internal coat* is mucous, and of a deep yellow color after death, owing to the imbibition of bile, but a grayish pink during life. The free surface of this membrane presents a beautiful honey-comb appearance, and is marked by numerous crests or folds intersecting each other in every direction, and inclosing polygonal spaces, which are again subdivided by still smaller crests into alveoli or pits, visible through a common magnifying-glass. The epithelium is of the columnar variety.

The *Cystic Duct* is the continuation of the neck of the gall bladder, and is composed essentially of the same structures. It is about the size of a crowquill, measures an inch or more in length, and is directed down ward and a little forward between the layers of the hepatico-gastric omentum to unite at an acute angle with the hepatic duct. The union of the two constitutes the common bile duct. Its internal or mucous coat is similar to that of the gall bladder, but presents a remarkable valve-like spiral fold which is permanent, and supposed to be intended to divert the bile from the hepatic duct. In order to see this valve it is necessary to inflate and dry the duct, and then lay it open in a longitudinal direction.

The gall bladder is supplied with blood through the *cystic artery*, a small branch of the hepatic, which ramifies between its coats and terminates in the mucous membrane.

The *Hepatic Duct* lies in front of the hepatic artery, from which it may be readily distinguished by the bright yellow color given to it by the *post-mortem* transudation of its contained bile. It commences in the substance of the liver by minute radicles, and these uniting with each other, form two principal trunks, which may be seen converging to make a junction at the bottom of the transverse fissure. From this point it is directed downward and a little forward, between the layers of the hepatico-gastric omentum, and, at about an inch or an inch and a half from the liver, unites at an acute angle with the cystic duct (Fig. 145) to form the common bile duct.

The *Common Bile Duct* (ductus communis choledochus) (Fig. 145) continues in the same general direction as the preceding; gets between the head of the pancreas and the vertical division of the duodenum, is here joined by the pancreatic duct, and the two enter the duodenum in company, and, after passing between its coats for a few lines, open upon its interior close together or by a common orifice upon its left wall about four inches below the pylorus. Their orifices are very small and situated upon the apex of a little papillary eminence of the mucous membrane.

The walls of the hepatic and common bile ducts consist of an external coat of fibro-muscular tissue, and of an internal lining of mucous mem-

brane, whose free surface is covered by a columnar epithelium, and marked by the openings of numerous little racemose glands, the precise function of which is not known.

THE PANCREAS.

The Pancreas (Fig. 134) is a long, narrow, glandular organ of a pale, pinkish color, situated transversely across the upper back part of the abdomen, and extending from the spleen to the descending or vertical portion of the duodenum. It is flattened from before backward, broad at its left or duodenal extremity, and has been likened in shape to a hammer, or rather to a dog's tongue. It is moderately firm in its texture, measures from six to eight inches in length, one to one and a half in breadth, and from four to six lines in thickness, and weighs from two to two and a half ounces. Its right or large extremity, called also the *head*, is embraced by the curvature of the duodenum, to whose vertical portion it is closely attached by areolar tissue, and by the pancreatic duct. Its left extremity or *tail* is in contact with the concave surface of the spleen.

The *anterior surface* is loosely covered by peritoneum, and is in relation with the posterior surface of the stomach, by which it is entirely concealed from view when the abdomen is first opened. The *posterior surface* rests upon the aorta, inferior cava, and left suprarenal capsule, to all of which it is attached by open areolar tissue. The *superior border* passes directly beneath the cœliac artery, and from this point to the left extremity is furrowed by the splenic artery, which is imbedded in its substance, and from which it receives a number of arterial twigs. The *inferior border* is thinner than the superior, and, near the head, is split obliquely upward and toward the right side, to give passage to the superior mesenteric artery and vein. That portion of the organ lying to the right of this fissure being thus somewhat separated from the remainder, is sometimes called the *lesser pancreas.*

Structure, etc.—The structure of the pancreas very nearly resembles that of the salivary glands; hence it has been sometimes called the abdominal salivary gland. It is composed of numerous lobes and still smaller lobules, held together by areolar tissue, and by vessels and ducts, and invested externally by a loose areolar net. The lobules which compose the lobes are much larger than the lobules of the liver, but, like the latter, are isolated from each other by areolar septa, and contain in their substance the ramifications of the bloodvessels and excretory duct.

The *arteries* of the pancreas are derived principally from the splenic and pancreatico-duodenal, the latter a branch of the hepatic; a small branch is also received from the superior mesenteric. The *nerves* are branches of the solar plexus. The *lymphatics* empty into the lumbar glands.

The office of the pancreas is to secrete a clear mucuslike fluid for the

purposes of digestion. The particular use of this fluid, however, is not positively ascertained, but, from experiments made within the last two or three years by M. Bernard, it would seem to be intended to emulsify the oleaginous matters of the food, and thus fit them for absorption.

The Pancreatic Duct.—The main trunk of the pancreatic duct, generally single but sometimes double, commences in the left extremity and passes through the whole length of the axis of the gland, receiving the small ducts from the lobes, and gradually increasing in size as it approaches the head. Here it receives a large branch from the lower part of the head or lesser pancreas, and, meeting with the common bile duct from above, turns downward, enters the left wall of the duodenum, and, after passing a short distance between the coats of this intestine, the two open, by a common orifice, or separately upon the apex of a small eminence or ampulla, about three or four inches from the pylorus.

The external coat of the pancreatic duct is composed of dense areolar tissue. The internal layer is mucous, covered by a columnar epithelium.

THE SPLEEN.

The Spleen (Fig. 134) is situated in the left hypochondriac region, behind the left extremity of the stomach and the cartilages of the ninth, tenth, and eleventh ribs. It is semi-ovoid in shape, of a bluish color externally, but dark brown or brownish red within, and, although not always of the same consistence, is in general remarkably fragile or friable, and hence liable to be fractured or lacerated by external violence. On pressure between the thumb and fingers, it imparts a crackling or crepitant sensation, produced by a partial rupture of its internal structure. In point of size, no organ in the body is so inconstant within the limits of health; but its average length may be stated at about five inches, its breadth from three to four inches, its thickness one and a half inches, and its weight from five to seven ounces.

The spleen is usually single, but it is not uncommon to find in its immediate vicinity one or more supernumerary organs of the same kind, which have generally a spheroidal form, and vary in size from that of a pea to that of a walnut. Being a half ovoid, it presents for consideration a convex and a flat surface, and an oval border. The *convex surface* is smooth and free, and in contact with the diaphragm by which it is separated from the lower margin of the left lung, and the ninth, tenth, and eleventh ribs. The *flat surface* is separated into two parts by a longitudinal groove or fissure called the *hilus*, which is situated a little nearer the posterior than the anterior margin, and gives passage to the vessels. It is here also that the peritoneal covering of the organ passes off to the stomach in a fold, called the splenico-gastric omentum. In front of the

hilus, this surface is in contact with the great end of the stomach and left extremity of the transverse colon; behind, it is in relation with the left kidney, suprarenal capsule, tail of the pancreas, and left pillar of the diaphragm. The *circumference* is thick and rounded, and not unfrequently notched or fissured so as to give the organ a lobulated appearance.

Structure.—The spleen consists of two investing membranes and a proper tissue. The *external* of the two coverings is serous, derived from the peritoneum, and deficient only in the longitudinal fissure. The second or *proper* coat is fibro-elastic and strong, not generally very thick, but liable to become so by disease; it is connected to the external by short, dense, areolar tissue, and prolonged throughout the substance of the organ in numerous small bands or cords (trabeculæ), which, crossing each other in every direction, inclose interspaces for containing the special tissue. The latter is a pultaceous, grumous-looking substance of a dark reddish or purple brown color, which becomes brighter on exposure to the air. Under the microscope, it is found to consist of minute granular bodies about the size of blood corpuscles, intermixed with tufts of arteries and veins, and groups of small white vesicular bodies called *Malpighian corpuscles.*

Vessels and Nerves.—The spleen is supplied with blood by the splenic artery, a branch of the cœliac, which runs in a serpentine manner along the upper border of the pancreas, and, having reached the hilus, divides into three or four terminal branches, which enter the organ, and, what is remarkable, do not anastomose, but remain separate even to their most minute ramifications. As before mentioned, the splenic artery supplies numerous small twigs to the pancreas, and from the terminal branches in the hilus are sent off those small recurrent arteries (gastric branches or vasa brevia), which, traversing the gastro-splenic omentum, are distributed upon the large end of the stomach. The *veins* are large and numerous, and all unite to form a single trunk four or five times larger than the artery, which lies in a groove upon the posterior surface of the pancreas, and unites with the superior mesenteric vein to form the portal vein. The *lymphatics* are very numerous, and form a superficial, and a deep-seated plexus, the former situated beneath the serous coat, and the latter in the substance of the organ; the two sets communicate in the fissure, and, proceeding along the gastro-splenic omentum, enter the neighboring ganglia. The *nerves* are branches of the solar plexus, and enter the organ supported by the vessels.

The functions of the spleen, like those of the ductless glands in general, are still a matter of question.

THE KIDNEYS.

The Kidneys, two in number, belong to the genito-urinary apparatus; but, having been exposed by the removal of the digestive organs, and hence liable to become offensive, they should be now examined. They are situated deep in the lumbar regions upon either side of the spine, opposite the two inferior dorsal and two upper lumbar vertebræ; the right generally a very little lower than the left. It is not uncommon, however, to find one or both in the iliac fossæ, and more rarely even in the cavity of the pelvis. They are of a deep brownish-red color, firm consistence, and oval figure, flattened from before backward. They measure about four inches in length, two in breadth, and one in thickness, and weigh from four to six ounces. The *anterior surface*, convex, looks forward and a little outward, and is loosely covered with the peritoneum lining the posterior wall of the abdomen, a quantity of adipose and open areolar tissue intervening. The *posterior surface*, less convex than the anterior, looks backward and inward, and rests upon the upper extremity of the psoas and square lumbar muscle, and the lower back part of the diaphragm, by which it is separated from the eleventh and twelfth ribs. The *circumference* is thick and rounded, and presents internally a deep vertical fissure called the *hilus of the kidney* (hilus renalis), at which the vessels enter and leave the organ. The upper extremity of each is embraced by the suprarenal capsule, is somewhat larger than the inferior, and nearer the spine, so that the axes of the two organs slightly diverge from above downward.

The right kidney is in relation, in front, with the under surface of the liver, the vertical portion of the duodenum, and the ascending colon; the left, with the posterior surface of the stomach, the lower extremity of the spleen, the pancreas, and the descending colon.

Structure.—Each kidney is provided with a thin but dense fibrous tunic, which is closely attached to the whole of the exterior of the organ by short areolar tissue, dips into the hilus, and becomes continuous with the external coats of the vessels. In order to demonstrate this covering, it is only necessary to make an incision along the outer border of the organ, when it may be readily stripped off from either surface with the forceps.

The substance of the kidney, as seen with the unassisted eye, appears to consist of two entirely distinct structures, the one called cortical or granular, and the other medullary or tubular. The *cortical substance* forms, as its name indicates, the exterior of the organ, where it exists as a layer of two or three lines in thickness, and having prolongations which extend internally between the masses of tubular substance. It is moderately firm and consistent, of a reddish-brown color, and upon a clean section pre-

sents a dark speckled or dotted appearance. The *tubular substance* is of a darker color and firmer consistence than the cortical, and arranged into pyramidal or conical masses, called renal pyramids.

Fig. 146.

Longitudinal section of kidney, with its renal capsule. 1, renal capsule; 2, cortical part of kidney; 3, 3, uriniferous tubes collected into pyramids; 4, 4, papillæ, projecting into their corresponding calyces; 5, 5, 5, dilatations of pelvis of kidney; 6, 7, ureter.

Fig. 147.

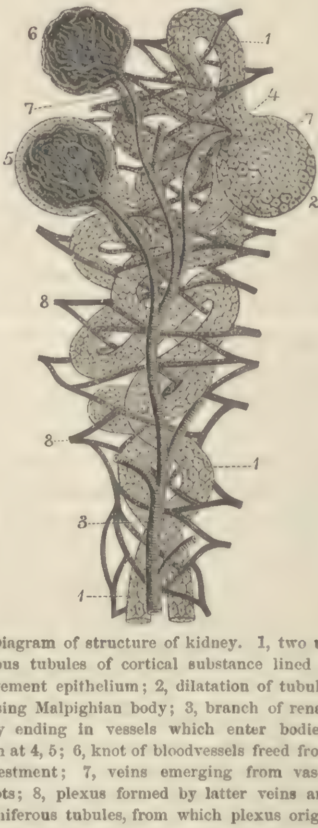


Diagram of structure of kidney. 1, two uriniferous tubules of cortical substance lined with pavement epithelium; 2, dilatation of tubule inclosing Malpighian body; 3, branch of renal artery ending in vessels which enter bodies, as seen at 4, 5; 6, knot of bloodvessels freed from its investment; 7, veins emerging from vascular knots; 8, plexus formed by latter veins among uriniferous tubules, from which plexus originate branches of renal vein.

The *pyramids* vary from twelve to fifteen in number, and are continuous at their bases with the cortical substance in which they are imbedded. Their apices, called *papillæ,* are free, and project into the calyces of the ureter. Examined with the microscope, the proper tissue of the kidney is found to be composed of minute tubes or tubules, which open upon the extremities of the papillæ. Traced from this point they pass outward in straight lines through the pyramids, at the bases of which they become tortuous and in the cortical substance are coiled upon themselves. Followed out to its remote terminations, each tubule ends in a flasklike dilatation or pouch, which incloses a tuft of capillaries, the two constituting what is known as the *Malpighian body.* The tubule is composed of structureless membrane lined by a squamous epithelium, which in the pouch is reflected over the plexus of bloodvessels. The latter are derived from a branch of the renal artery, which, entering the pouch, breaks up into a multitude

of capillaries; these, anastomosing together, form an intricate plexus in the shape of a ball within the pouch, and terminate in a single venule which, leaving the pouch, unites with similar vessels to form a retiform plexus around the convolutions of the tubule.

Such, then, in few words, is the intricate structure of the kidney, and it may be added that no other gland in the body has yielded results so satisfactory to the microscopist, who is entitled, indeed, to point to this organ as one whose structure has been thoroughly elucidated.

Vessels and Nerves.—The *renal arteries* are large, and pass off at right angles from the aorta. The *renal veins* are much larger than the arteries, and open into the inferior cava. The *nerves* are derived from the solar plexus, and unite with the lesser splanchnic nerve coming from the cavity of the thorax to form an intricate network upon the renal artery, which is called the renal plexus. The *lymphatics* leave the organ at the hilus, and terminate in the lumbar lymphatic glands.

The **Ureter**, the excretory duct of the kidney, commences at the bottom of the hilus by short cylindrical prolongations called *calyces*, which are attached around the papillæ, a short distance from their apices, and embrace them as the breast-glass embraces the nipple in the operation of drawing off the milk. The calyces vary in number from eight to ten or twelve, some receiving only one papilla, and others two and occasionally three. They all communicate with each other, forming one common receptacle, called the *pelvis of the kidney*, which is somewhat funnel-shaped, but flattened from before backward and bent downward. It is situated behind the renal vessels, and, when inflated, occupies nearly the whole of the fissure, a little way external to which it becomes narrowed down to the size of an ordinary goosequill, which size it maintains throughout the rest of its course.

From the hilus of the kidney, the ureter turns almost vertically downward, and passes, behind the peritoneum, into the lower back part of the pelvis, where it terminates in the base of the bladder by perforating the walls of this cavity obliquely. Its length varies from twelve to eighteen inches; its size, as just mentioned, does not usually exceed that of a goosequill, but is liable to great augmentation when any obstacle occurs to the passage of the urine.

The ureter is covered by the peritoneum in front, and crossed obliquely by the spermatic vessels. It crosses the psoas muscle, running at first along its outer margin, and then the common and internal iliac vessels, the obturator artery and vein, and the spermatic duct.

Structure.—The ureter is composed of three coats: 1, a fibrous membrane which is continuous at the bottom of the hilus of the kidney with the fibrous covering of that organ; 2, a layer of smooth or unstriped muscular fibres, both longitudinal and circular; and 3, a lining of mucous

membrane covered by an epithelium of spheroidal cells, continuous upon the one hand with the epithelial covering of the papillæ and lining membrane of the renal tubules, and on the other with the mucous membrane of the bladder.

THE SUPRARENAL BODIES.

The Suprarenal Bodies or Capsules are two small glandular-looking bodies, pyramidal in shape, flattened from before backward, and resting by their bases upon the superior extremity of each kidney. The upper border or apex of each is thin, the base nearly half an inch in thickness, an inch and a half in length, and excavated for the reception of the top of the kidney. They consist of an external, thin, fibrous envelope, and an internal proper tissue, divisible into an external cortical substance, of a deep brownish-yellow striated appearance, and an internal dark-brown pulpy substance, occupying the interior of the organ. The true nature of these two substances has not, however, been satisfactorily established.

Each capsule receives three minute arteries, one from the diaphragmatic, one from the aorta, and one from the renal artery. The vein is generally single; that upon the right side opening into the cava, and that of the left into the renal vein. No excretory duct has ever been discovered coming from these organs, and their function is as yet an entire mystery. We know, however, that they have some essential connection with fœtal life, from the fact that they are proportionably much larger at this than at any later period, and gradually diminish in size as age advances. They have received much attention of late from their supposed implication in the affection known as Addison's disease.

THE MALE PELVIS AND ITS CONTENTS.*

In the skeleton, the Pelvis is that division of the trunk formed by the sacrum, coccyx, and innominate bones, and is subdivided by the promontory of the sacrum and ilio-pectineal lines, into the false and true pelvis. In a practical point of view, however, the false pelvis, the space included between the flaring portions of the ilia, is properly a part of the abdomen; but the true or lesser pelvis is an entirely separate division, to which the general term pelvis will be here restricted, which, considered in this light, is a curved, cylindrical cavity, whose concavity presents forward. It communicates above with the abdomen by the large opening known as the superior strait of the pelvis, and is closed below by the soft parts designated the perineum.† Its contents are the rectum, bladder and its appendages, internal iliac vessels and their branches, elevator of the anus, internal obturator and pyriform muscles, and sacral plexus of nerves. The perineum should be first dissected.

THE PERINEUM.‡

The Perineum of the Male, one of the most important surgical regions of the body, is situated at the inferior extremity of the trunk, between the thighs and behind the external organs of generation; it extends from the point of the coccyx behind to the pubic symphysis in front, and is bounded on each side by the sacro-ischiatic ligaments and the tuberosity of the ischium. In the ordinary positions of the body, its form is that of a narrow fissure between the thighs, but when the latter are separated and flexed upon the pelvis, it presents itself as a quadrilateral space, measuring about four inches both antero-posteriorly and transversely.

* If the subject upon which the student is engaged is a female, he may pass over this section, devoted to the male pelvis and organs of generation, and turn to the directions given for the study of the female organs of generation.

† The term perineum, when used in an obstetric sense, is limited to the space in the female included between the lower extremity of the rectum and the vagina.

‡ While one student is making the dissection of the perineum, which is necessarily slow and tedious, another may be engaged upon the head preparatory to removing the brain.

Dissection.—Place the subject as in the lateral operation for stone in the bladder, *i.e.* flex the legs upon the thighs, and the thighs upon the pelvis, tie the hands to the feet or ankles, bring the buttocks to the edge of the table, and have the limbs held apart by a stick three or four feet long placed between the knees.

The skin of the perineum, as also that of the scrotum, is of a darker color than in most parts of the body, and presents in the middle line a well-marked ridge or raphe, continued forward upon the scrotum, and terminating at the anterior margin of the anus. Some distance upon either side of this ridge, the tuberosity of the ischium may be readily felt, forming the lateral boundary of the perineum.

The **Anus**, the outlet of the large bowel, is situated in the middle line at the back part of the perineal space. It is circular in shape, small but very dilatable, and always closed except during defecation. The skin in the immediate neighborhood is thin and provided with numerous sebaceous follicles and hairs, and, as it enters the opening to become continuous with the mucous membrane of the bowel, it forms a number of radiating folds. The union between the two tissues is marked by a well-defined festooned or scolloped line, situated two or three lines within the orifice.

Dissection.—Divide the skin by a transverse incision, either straight or curved, and three or four inches long, just behind the scrotum, and from its two extremities make two others running backward along the inner side of the prominences, formed by the tuberosities of the ischia, as far as the level of the point of the coccyx. Turn back the flap of skin together with a small quantity of subcutaneous areolar tissue, so as to expose the superficial perineal fascia and the sphincter muscle of the anus. To assist in making a clean dissection of the latter, it will be necessary to make it tense by hooks fastened in front, and by the introduction of a piece of sponge or cotton into the rectum.

The **Subcutaneous Areolar Tissue** in this region is loose and open, and, being subject to a deposition of fat, varies in its thickness in different individuals. It is mainly owing to the presence of a large amount of fat in this structure that the perineum in some persons is found to be so much deeper than in others.

The **Superficial Perineal Fascia** lies beneath the subcutaneous areolar tissue, and is continuous with it by its superficial surface. It is quite dense and strong in front where it is attached to the rami and tuberosities of the ischia and continuous with the dartos coat of the scrotum, but behind it is rather loose and open, infiltrated with more or less adipose tissue, and continued upward in front of the rectum to join the posterior border of the deep fascia. In consequence of this disposition of the fascia, urine escaping from the back part of the urethra is directed forward into the scrotum instead of passing down upon the thighs.

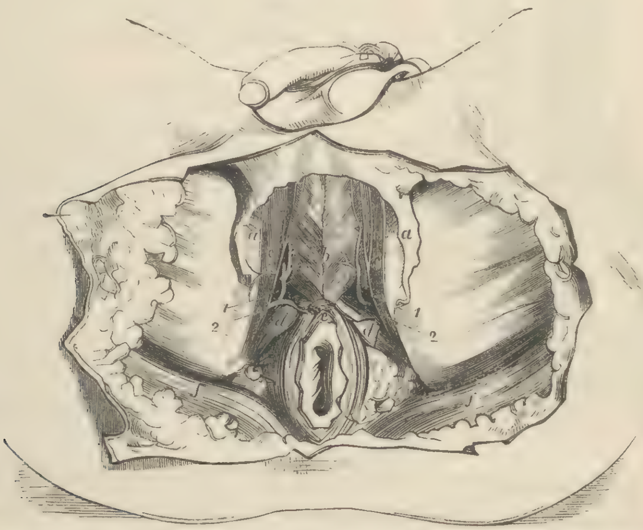
The superficial perineal fascia is in relation by its deep surface with the root of the penis, the transverse muscle, a part of the elevator of the

anus, and the external sphincter muscle. To expose these structures, make the following dissection:

Dissection.—Cut the superficial fascia across in front and along the rami and tuberosities of the ischia, and turn it carefully back; in doing this, observe its loose continuity with the deep fascia in front of the anus. This done, cut it off behind and proceed to dissect out the areolar tissue, which fills up the interspaces of the subjacent parts. Or it may be divided along the middle line and turned outward like a pair of folding doors.

The space now brought into view is somewhat triangular in shape, one angle being formed in front by the converging branches of the ischia, and the two others presenting backward and outward on each side of the anus. It contains the following structures (Fig. 148): 1. In the middle line in

Fig. 148.



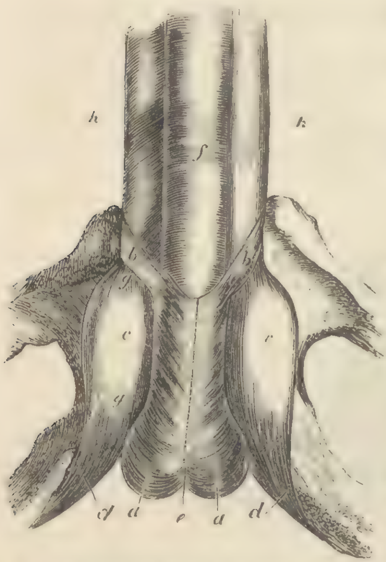
Perineum and part of thighs, after skin and portion of superficial fascia have been removed. *a*, superficial fascia; *b*, bulb of penis covered by its compressor muscle; *c*, root of right cavernous body covered by ischio-cavernous muscle; *d*, transverse perineal muscle; *e*, anterior extremity of sphincter muscle of anus; *f*, edge of great gluteal muscle. 1, superficial perineal artery; 2, superficial perineal nerve.

front, the posterior extremity of the spongy portion of the penis, called the bulb of the penis,[b] covered by its compressor muscle; 2, behind, in the middle line, the anus surrounded by its sphincter muscle;[e] 3, on each side, the leg (crus) or root of the corresponding cavernous body of the penis,[c] diverging from its opposite fellow to its attachment along the ramus of the ischium, and also covered by a special muscle; 4, the transverse muscle of the perineum,[d] accompanied by a very small artery and nerve; 5, a part of the lower surface of the elevator muscle of the anus, its fibres directed transversely; 6, the superficial perineal vessels and nerves.

The **External Sphincter Muscle of the Anus**, thin, flat, and elliptical, consists of two lateral planes of fibres, which originate by a tendinous band from the point of the coccyx, pass in a curved manner around the anal orifice, and are inserted into the middle tendinous line of the perineum, a short distance back of the bulb of the penis.

Use.—To close the included orifice. It also makes the median raphe of the perineum tense, thus furnishing a fixed point of action for the transverse perineal muscles, and the compressor muscle of the bulb of the penis. It is supplied with arterial twigs from the inferior hemorrhoidal, which are branches of the internal pudic arteries. Its nerves are offsets from the inferior hemorrhoidal, and, belonging to the cerebro-spinal system, place the muscle under the control of the will.

Fig. 149.



Parts of pubes and ischia with roots of cavernous bodies attached. *a*, *a*, compressor muscle embracing bulb of spongy body; *b*, *b*, anterior slips of same passing round cavernous bodies to dorsal surface of penis; *c*, *c*, roots of cavernous bodies covered by *d*, *d*, erector or ischio-cavernous muscles; *f*, spongy body of penis; *h*, *h*, cavernous bodies of penis.

The **Bulb of the Penis*** is the large, rounded, posterior extremity of the spongy body, and projects into the perineum as far backward as the anterior extremity of the sphincter muscle, resting here against the anterior surface of the deep perineal fascia. It is traversed from behind forward near its upper surface by the urethra, which is here sometimes called the sinus of the bulb. Its lower surface is covered by a thin layer of muscular fibres named the compressor of the bulb.

The **Compressor Muscle of the Bulb** (*accelerator urinæ*) (Figs. 148 and 149) is a thin muscular

* In order to display the bulb to advantage, it is necessary to inflate the spongy body of the penis, which may be done through the great dorsal vein. This vessel is situated close upon the upper surface of the organ directly in the median line, and may be exposed by a short longitudinal incision through the skin and superficial fascia just in front of the pubis. The student must be sure he has the right vessel, for there are one or two superficial veins in this region which are apt to be mistaken for it. Having found it, open it by a small incision, and before introducing the blowpipe run a probe along its cavity in an anterior direction for the purpose of breaking down a valve situated about midway in its course, which would otherwise prevent the passage of the air.

bag which suspends the bulb, as it were, in a sling. It is divisible into two lateral halves, which meet in a common tendinous raphe or seam extending from the anterior extremity of the sphincter along the under surface of the spongy body for the distance of an inch or more. The muscular fibres originate from the raphe, spread out obliquely upon the bulb, so as to surround it completely, and meet in the middle line upon its upper surface. Two small slips, however, comprising the most anterior fibres of the muscle, pass outward and forward over the cavernous bodies of the penis to be inserted into the upper surface of the same. By its contraction the muscle expels the last drops of urine from the urethra.

The **Crura of the Cavernous Bodies** are situated upon the sides and in front of the bulb. They diverge from before backward to become attached to the rami of the ischia, and from what is commonly known as the root of the penis, and are each covered by a small muscle called the ischio-cavernous.

The **Ischio-cavernous Muscle** (*erector penis*) (Fig. 149, d) arises by tendinous and fleshy fibres from the inner edge of the tuberosity of the ischium, ascends forward and a little inward upon the under surface of the corresponding crus, and terminates in a thin aponeurosis that becomes spread out and continuous with the fibrous coat of the penis. Its principal use seems to be to steady the penis in a horizontal direction during erection.

The **Transverse Perineal Muscle** (Fig. 148, d), small, pale, and slender, and not unfrequently wanting, arises from the inner side of the tuberosity of the ischium, passes transversely and a little forward across the perineum, and is inserted into the middle raphe, just where the anterior extremity of the sphincter of the anus meets the posterior extremity of the compressor of the bulb. It is covered by the superficial, and rests upon the deep perineal fascia.

Sometimes a second, but very small transverse muscle (*transversalis alter*), is found running from the tuberosity of the ischium, in front of the preceding, to the compressor of the bulb.

By the transverse muscle the superficial perineal region is divided on each side into an anterior and a posterior triangular space. 1. The *Anterior* or *Ischio-bulbous Space*, the smaller of the two, and quite narrow, is included laterally between the root of the cavernous body and the bulb of the penis; upon separating which, and removing a quantity of loose areolar tissue, its bottom or floor will be found to be formed by the deep perineal fascia. It contains the superficial and transverse perineal arteries and superficial perineal nerve. The *superficial perineal artery* (Fig. 148, 1) is a small branch of the external pudic, where it lies along the inner surface of the tuberosity of the ischium; it makes its appear-

ance upon the inner side of the origin of the ischio-cavernous muscle, passes forward and toward the surface, and, having reached the angle formed by the cavernous and spongy bodies, is distributed to the special muscles of these organs, and the integument and under surface of the penis. The *transverse artery*, a small offset from the preceding, runs along the anterior margin of the transverse muscle, and is distributed to the sphincter, skin, and other adjacent structures. The *superficial perineal nerve*,[2] also quite small, follows the artery, being derived from the internal pudic nerve, which accompanies the artery of the same name. 2. The *Posterior Perineal* or *Ischio-rectal Space*, much larger than the preceding, is a deep conical excavation occupied by areolar and adipose tissue. It is bounded externally by the inner surface of the tuberosity and body of the ischium, and internally by the side of the lower extremity of the rectum and the elevator muscle of the anus. It is important as the frequent seat of suppurative inflammation, and also as the situation in which the posterior extremity of the oblique incision, made in the lateral operation of lithotomy, terminates.

The **Internal Pudic Artery** and its accompanying nerve form a very important part of the anatomy of the perineum, but they can be seen only in part in this dissection. The artery is about the size of a crow-quill, and a branch of the internal iliac; it descends from the cavity of the pelvis through the greater ischiatic foramen, curves over the posterior surface of the spine of the ischium, enters the lesser ischiatic foramen, and ascends forward along the inner face of the tuberosity and ramus of the ischium, to reach the root of the penis. Lying at least an inch from the border of the tuberosity, it is almost entirely out of danger in the operation of lithotomy, unless the edge of the knife is lateralized to a very unnecessary degree.*

The **Internal Pudic** or **Perineal Nerve** is derived from the sacral plexus; it follows nearly the same course as the pudic artery in the perineum, lying upon the under side of this vessel, and is distributed to the integuments and muscles of the perineum and root of the penis.

Dissection.—Dissect off the compressor muscle of the bulb, the transverse muscle, superficial perineal artery and nerve, and a quantity of surrounding loose areolar tissue; cut away the crura from the rami of the ischia, push the bulb to one side, and detach the sphincter in front, and the deep perineal fascia will be brought into view.

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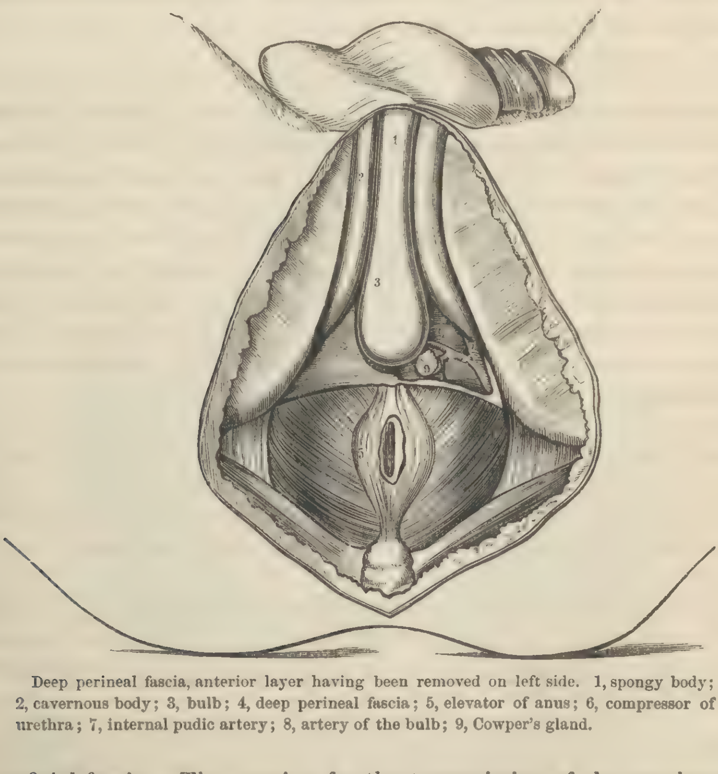
* The size of the pudic artery is subject to considerable variation; but when very small, an *accessory pudic artery* is sometimes found to exist, which generally leaves the main trunk in the great sciatic foramen, passes forward over the prostate gland. and then along by the membranous portion of the urethra, to terminate in the artery of the bulb. When present, which happily is rarely the case, this accessory vessel is very liable to be wounded in the division of the membranous portion of the urethra and prostate gland, in the lateral operation of lithotomy.

The **Deep Perineal Fascia** (Fig. 150), called more frequently the *triangular ligament of the urethra*, and sometimes the anterior layer of the deep perineal fascia, to distinguish it from a still deeper layer, is a thick, strong, triangular, fibrous membrane, stretched across the front of the pubic arch, for the purpose of closing and giving strength to this part of the inferior strait of the pelvis. It is attached on each side to the inner face of the rami of the pubes and ischia, as far as the prominent part of the tuberosity of the latter, and is continued backward, in an attenuated form, to the anterior surface of the lower extremity of the rectum, where it blends with the surrounding areolar tissue, and the continuation of the superficial fascia. It is perforated, in the middle line in front, for the anterior extremity of the membranous portion of the urethra, and is in relation by its anterior or superficial surface with the bulb of the penis, and the other structures already described as lying underneath the

Fig. 150.



Deep perineal fascia, anterior layer having been removed on left side. 1, spongy body; 2, cavernous body; 3, bulb; 4, deep perineal fascia; 5, elevator of anus; 6, compressor of urethra; 7, internal pudic artery; 8, artery of the bulb; 9, Cowper's gland.

superficial fascia. The opening for the transmission of the membranous portion of the urethra is situated about an inch below the lower edge of the pubic symphysis, is circular in shape, and corresponds in size to that of the canal by which it is occupied. Its circumference does not, how-

ever, present a well-defined edge, but is continuous in front with the fibrous envelope of the spongy body of the penis.

Dissection.—If the deep perineal fascia be detached in front, dissected from the membranous portion of the urethra, and turned back, it will be found continuous behind with another layer of fascia, called the posterior layer of the deep perineal fascia, but which is properly a dependency of the fascia lining the interior of the pelvis. Considered, however, as a separate fascia, this layer is attached, above and laterally, to the posterior edge of the highest part of the pubic arch, and continuous below with the posterior surface of the triangular ligament just below its transverse middle. Above this point of union the two are separated by a small flattened triangular space, containing the membranous portion of the urethra and its compressor muscle, the arteries of the bulb, Cowper's glands, and a large plexus of veins.

The **Membranous Urethra** is about an inch in length, and about the size of a large goosequill. It is continuous behind with the prostatic, and in front with the bulbous portion of the canal, and directed from behind forward, and a little upward. In its course forward, it traverses the space just described, its anterior extremity occupying the circular opening in the triangular ligament, and its posterior, a similar but less distinct opening in the posterior layer of the same.

Cowper's Glands are two small spherical bodies of a pinkish color, and about the size of peas, situated behind the triangular ligament, and below the membranous portion of the urethra. They have a rough granular exterior, and resemble the salivary glands in structure, being composed of numerous little rounded lobules, held together by areolar tissue. Each gland is provided with a long slender duct, which enters the wall of the membranous portion of the urethra, runs forward about half an inch between its coats, and opens into the bulbous portion of the tube. Their office is to secrete a viscid mucuslike fluid, the use of which, however, is unknown. They are in relation in front with the transverse division of the compressor muscle of the urethra, and above with the arteries of the bulb.

The **Artery of the Bulb**, a vessel somewhat larger than the superficial perineal, is one of the terminal branches of the internal pudic. From its origin upon the inner side of the ascending ramus of the ischium, upon a level with the membranous portion of the urethra, it passes transversely inward behind the triangular ligament, curves over the corresponding Cowper's gland, to which it gives a small twig, perforates the deep perineal fascia by the side of the anterior extremity of the membranous portion of the urethra, enters the bulb, and is distributed to the spongy portion of the penis. Sometimes this vessel curves along the perineum nearer the rectum than here indicated, and is then liable to be wounded in lithotomy; but ordinarily it is too far forward to be much endangered, unless the incision is extended more than is necessary in this direction.

The **Compressor Muscle of the Urethra*** surrounds the membranous urethra throughout the greater part of its extent. It consists of two lateral slips, each of which originates from the corresponding side of the arch of the pubis at the junction of the rami of the ischium and pubis, passes transversely inward, spreads out and joins its fellow of the opposite side above and below the urethra. Two additional slips are sometimes mentioned under the name of Wilson's muscle, as descending from the highest point of the arch of the pubis, and mingling its fibres with those just described, but they do not seem to be constantly present, and are never very well defined.

Fig. 151.

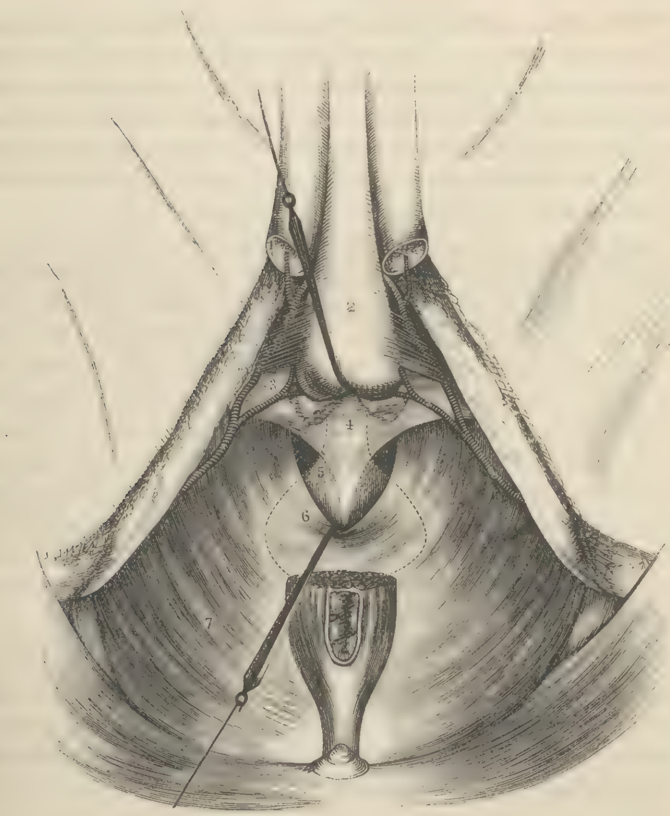


Diagram of parts behind triangular ligament of urethra. Anterior fibres of elevator of anus are hooked down to show part of prostate; the rest is tracked by dotted line. 1, root of cavernous body; 2, bulb; 3, compressor muscle of urethra; 4, membranous part of urethra surrounded by compressor muscle; 5, prostate gland; 6, anterior border of elevator muscle of anus; 7, elevator muscle of anus; 8, artery of bulb; 9, internal pudic artery.

* To expose this muscle completely it is necessary to saw through the rami of the pubes above the root of the penis, and dissect off the plexus of veins and the areolar tissue so as to obtain a view of the membranous urethra from above.

The office of the compressor muscle is to close the membranous urethra and thus assist in retaining the urine in the bladder. Its spasmodic contraction gives rise to temporary stricture.

The *Venous Plexus*, also found in the space between the two layers of the deep perineal fascia, receives the dorsal veins of the penis, which perforate the anterior layer above the urethra. It is remarkable for the number and tortuosity of its vessels, which, being bound together by tolerably firm fibro-areolar tissue, do not readily collapse when divided, and are hence liable to furnish a considerable amount of blood, if cut in the operation of lithotomy.

The **Elevator Muscle of the Anus** (*levator ani*), which is partly exposed in this dissection, separates the perineum from the pelvis. Its origin cannot at present be seen, but its inferior surface, which is here brought into view, is convex, and its fibres will be observed to pass transversely toward the median line, to be inserted into the lower extremity of the rectum; into its fellow of the opposite side, in the space between the rectum and bladder; and into the side of the prostate gland.

The depth of the perineum between the skin and the posterior layer of the deep perineal fascia and elevator muscle of the anus varies in different individuals from one to two or even three inches, depending, in a great measure, upon the development of the adipose tissue in the subcutaneous areolar tissue. This is an important fact in its connection with lithotomy, more particularly as the greater thickness does not always correspond with the general condition of the body, the development of fat being sometimes only local. Before operating, therefore, it is proper to examine with reference to this point, which may be done by introducing a catheter into the bladder, and then, with the index finger of one hand in the rectum, pressing with the other upon the perineum.

INTERIOR OF THE PELVIS.

To study the contents of the pelvis in their natural position, it is necessary to remove one (the right is preferable) of the lateral walls of the cavity, leaving the contained organs in connection with the opposite side. This may be done in the following manner:

Dissection.—Turn the scrotum and penis to the left side, and divide the soft parts down to the pubic symphysis a little to the left of the middle line; next, carefully dissect the root of the cavernous body of the penis from the right ischium, by scraping it off with the periosteum to avoid making an opening into its substance; then cut through the pubic symphysis, separate the thighs forcibly, dissect the bladder from its connection with the right wall of the pelvis, and divide successively the corresponding half of the elevator muscle of the anus, sacro-ischiatic ligaments, sciatic nerve, pyriform muscle, and common iliac vessels; lastly, tear the right ilium from the sacrum, by separating the thighs still farther, and cut through the muscular mass behind.

The viscera will now be found in the concavity formed by the sacrum, coccyx, and left innominate bone. The first thing to be done is to sponge the parts clean, trim off the ends of the muscles, areolar tissue, and other loose structures, inflate the bladder to a moderate degree through one of the ureters, and distend the rectum with cotton or hair.

Before any further dissection is performed, the student should notice the disposition of the pelvic portion of the peritoneum. Traced from above, this membrane descends into the posterior part of the pelvic cavity, upon the anterior and lateral surfaces of the rectum, which it attaches to the anterior surface of the sacrum by a reflected fold called the *meso-rectum.* This fold is broad above, but gradually narrows to its termination about four inches above the anus; here the membrane leaves the anterior surface of the rectum, passes forward to reach the bladder about an inch and a half or two inches behind its neck, ascends over the posterior surface and summit of this organ, and from its anterior surface reaches the anterior wall of the abdomen just above the pubic symphysis.

From the sides of the bladder, the peritoneum is reflected forward to the anterior walls of the pelvis and abdomen, forming the *anterior false ligaments* of the organ.

Dissection.—The reflections of the peritoneum having been examined, this membrane should be dissected from the left lateral wall and floor of the pelvis, and the bladder, and the rectum turned over toward the right, so as to display the pelvic fascia and the elevator muscle of the anus underneath the latter.

The **Pelvic Fascia** is a continuation of the iliac which covers the iliac and psoas muscles, from which it descends to invest the lateral and anterior walls of the pelvic cavity. From behind the symphysis of the pubes, it is continued over the superior surface of the prostate gland to the bladder; laterally, it is more dense and strong, and near the bottom of the cavity forms a thickened band, extending, in a curved direction, from the pubic symphysis downward and backward to the spine of the ischium. From the lower margin of this band, the elevator of the anus takes its origin, and the fascia here divides into a vesical and an obturator lamina.

The *vesical* layer covers the superior surface of the elevator of the anus, from which it is continued backward upon the anterior and lateral surfaces of the rectum, and forward over the posterior extremity or base of the prostate gland to the bladder, forming, where it reaches this organ on each side, its lateral *true ligaments.* If this layer of fascia is cut in lithotomy (as is sometimes the case where a too extensive division of the prostate gland is made), death almost invariably results from extravasation of urine into the pelvic cavity beneath the peritoneum.

The *obturator* division of the fascia cannot be seen until after the removal of the elevator of the anus; it covers the lower part of the internal obturator muscle, and the inner face of the tuberosity and ramus of the ischium, and is continuous with, or rather forms, the posterior layer of the deep perineal fascia, as previously mentioned.

Dissection.—The bladder and rectum having been turned out of the pelvis to the right so as to put the left segment of the elevator of the anus upon the stretch, dissect the vesical layer of the pelvic fascia from the surface of the muscle.

The **Elevator Muscle of the Anus** (*levator ani*) is a broad, thin muscle, stretched in an arched manner across the bottom of the pelvis, with its concavity presenting upward. It consists of two lateral halves or segments, which originate on each side from the posterior surface of the pubic symphysis; from the lower edge of the whole length of the thickened band of pelvic fascia extending from the pubic symphysis to the spinous process of the ischium; and from the inner surface of this process. The fibres descend inward, and are inserted into the side of the rectum some distance above the anus; into a median raphe extending from the rectum to the prostate gland; and into the sides of this gland.

Relations.—Its superior surface is covered by the vesical layer of the pelvic fascia, which separates it from the peritoneum behind, and from the base of the bladder in front. Its inferior surface (seen in the dissection of the perineum) is separated by a considerable quantity of fat, numerous veins, and the obturator layer of the pelvic fascia, from the structures constituting the deepest part of the perineum. Its anterior border is concave, and forms with the highest part of the pelvic arch an antero-posterior oval opening which is mainly occupied by the prostate gland.

Use.—To raise the rectum and bladder and the structures connected with these organs. It thus antagonizes the abdominal muscles, more particularly the diaphragm, and assists in defecation, and also in the expulsion of the semen and urine.

Dissection.—Dissect the peritoneum from the surface of the rectum and bladder.

The **Rectum** (Fig. 152) descends obliquely from its commencement upon the left side of the promontory of the sacrum, and, having reached the median line, continues along the concavity of this bone and the coccyx to the point of the latter, where it turns a little backward to terminate at the anus. It is held in its position above by the mesorectum, and below, by the pelvic fascia, the elevator of the anus, and by its attachment to the anus. It differs from the other portions of the large intestine in being smooth, cylindrical, and destitute of the three longitudinal bands and intervening saccules. It is not, however, of uniform size throughout, but an inch or two above the anus presents a considerable bulbous dilatation, which is liable to be much increased by long retention of the feces.

Relations.—It is in relation *behind* with the front of the left sacro-iliac symphysis, the concave surfaces of the sacrum and coccyx, the origin of the pyriform muscle, sacral plexus of nerves, and the hypogastric plexus of the sympathetic system; in *front*, with the back of the bladder,

one or more convolutions of the small intestine frequently intervening; with the elevator of the anus; with the base of the bladder and the seminal vesicles that form its lateral boundary; and with the prostate gland. It is covered by the peritoneum as far down as opposite the junction of the lower two pieces of the sacrum, that is, about four inches from the anal orifice.

Its close relations with the base of the bladder and the prostate gland are of great practical importance, as it enables the surgeon, by means of his finger introduced into the bowel, to explore these parts with great precision. Its structure has been already described (page 279).

Vessels and Nerves of the Rectum.—The *arteries* of the rectum are three in number and tolerably large; they are: 1, the superior hemorrhoidal, a branch of the inferior mesenteric; 2, the middle hemorrhoidal, a branch of the internal iliac; and 3, the external hemorrhoidal, a branch of the internal pudic. The *veins* are very numerous, and around the lower part of the bowel form a large and intricate plexus, constituting a kind of erectile tissue not unlike that of the penis; they terminate in the inferior mesenteric and internal iliac veins. The *nerves* are filaments from the sacral, mesenteric, and hypogastric plexuses, and belong, therefore, both to the cerebro-spinal and sympathetic systems.

VESSELS AND NERVES OF THE PELVIC CAVITY.

The Vessels and Nerves of the Male Pelvis will be fully described in connection with those of the Female (p. 342).

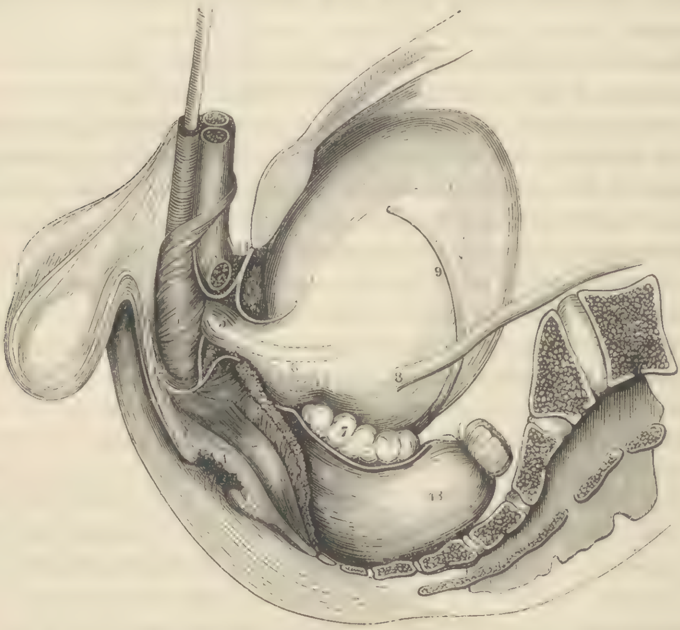
THE BLADDER.

The Bladder is a musculo-membranous sac for the reception and expulsion of the urine. When contracted and empty, it is situated deep in the anterior part of the pelvis, behind the symphysis and arch of the pubes, but, when distended, it fills the greater part of the cavity of the pelvis, and encroaches upon that of the abdomen. Its form is ovoidal; the larger extremity or base presents downward and backward, resting upon the elevator of the anus and forepart of the lower portion of the rectum; its summit is directed upward and forward, and lies behind and a little above the pubis. Its capacity varies, depending somewhat upon the habits of the individual, being larger in persons who are accustomed to empty the organ only once or twice a day. It will ordinarily contain, however, in the male adult about a pint of fluid.

It is considered as having an anterior, a posterior, and two lateral surfaces, a summit, and a base. The *anterior surface* is not invested by the peritoneum, but is connected by loose areolar tissue to the posterior surface of the pubic bones and their symphysis, and the internal obturator muscles. When the organ is much distended, it is in contact also with the anterior wall of the abdomen for the distance of an inch or more just

above the pubis and below the reflection of the peritoneum. This is one of the points where the organ may be opened without wounding the serous membrane. The *posterior surface* is free, and covered throughout by the peritoneum. It is in relation with the rectum, one or more coils of the small intestine frequently intervening, and crossed beneath its peritoneal investment, and near the base of the organ, by the spermatic or seminal ducts.

Fig. 152.



Side view of pelvic viscera. 1, external sphincter; 2, internal sphincter; 3, elevator of anus cut through; 4, compressor of bulb; 5, membranous part of urethra, surrounded by compressor muscle; 6, prostate gland; 7, seminal vesicle; 8, ureter; 9, deferential tube; 10, root of penis divided; 11, triangular ligament; 12, superficial perineal fascia; 13, rectum.

The *lateral surfaces* are covered by peritoneum above, but are connected below to the sides of the pelvis by loose areolar tissue and a continuation of the pelvic fascia; they are each crossed obliquely from below upward, forward, and inward, by a small fibrous cord, the remains of the hypogastric or umbilical artery of the fœtus, and in an opposite direction by the seminal duct on its way from the internal abdominal ring to the base of the bladder. The *summit* or top is covered by peritoneum, and connected to the anterior abdominal wall above the pubis by a reflection of the peritoneum, by a thick fibro-areolar band, which is the remains of the fœtal continuation of the bladder, called the *urachus*. The *base* or fundus looks downward and backward, is partly covered behind by the recto-vesical reflection of the peritoneum, and rests upon the elevator

muscles of the anus in front of the lower extremity of the rectum. The ureters enter this part of the organ on each side behind, and the seminal vesicles and ducts cross it from behind forward and inward, inclosing a triangular interval bounded behind by the reflection of the peritoneum, which corresponds to a triangular space upon the interior of the organ, called the *trigone* or *bas fond* of the bladder. This portion of the organ lies almost directly upon the lower extremity of the rectum, the elevator muscle and pelvic fascia alone intervening, and terminates anteriorly at the neck.

The *neck* is situated just in advance of the base. It incloses the commencement of the urethra, and is intimately associated with the base of the prostate gland. In children this is the lowest part of the organ, but, as age advances, the fundus expands downward, and in old persons, especially if the prostate gland is enlarged, forms a shallow pouch which they find great difficulty in emptying, and which, in consequence, is liable to become the seat of an accumulation of thick mucus.

Ligaments of the Bladder.—The bladder is held in its position by the urethra and by two sets of ligaments called false and true. The *false ligaments* are five in number, and are formed by the reflections of the peritoneum; two of them, the posterior or recto-vesical, extend from the sides of the rectum to the base of the bladder, two from the lateral surfaces of this organ toward the crural arch, inclosing the remains of the umbilical arteries, and the remaining one from the summit to the umbilicus, inclosing the urachus. The *true ligaments*, two anterior and two lateral, are continuations of the vesical division of the pelvic fascia; the *anterior* are dense and strong, and extend from the lower back part of the pubis to the front of the neck and lower part of the anterior surface of the organ, leaving between them a cellular interval occupied by a venous plexus, in which terminates the dorsal vein of the penis; the *lateral* are broad and thin, connected by one extremity to the sides of the prostate gland and neck of the bladder, and, by the other, continuous with the fascia covering the upper surface of the elevator muscle of the anus.

Structure of the Bladder.—The bladder consists of a mucous, fibro-areolar, and a muscular coat, and a partial investment of the peritoneum already described.

The *Mucous Coat*, the lining membrane, is of a light pinkish gray color. In the contracted state of the organ, it forms numerous temporary folds, resembling those found in the stomach, which are effaced by distention. In addition to these, there are sometimes permanent ridges, crossing each other in every direction, produced by a hypertrophied condition of the subjacent muscular bundles. It is continuous at the neck, with the lining membrane of the urethra, and, behind and external to the latter, with that of the ureters.

The orifices of the ureters are in the form of vertical slits in the mucous

membrane and situated about an inch and a half behind and external to the neck, and about the same distance apart. The points at which they reach the outside of the bladder are a few lines higher up; for they do not pass directly through the walls, but obliquely, so as to form a valve-like communication. By this arrangement the urine is prevented from regurgitating when the organ contracts.

The triangular surface marked off by a line drawn between the orifices of the ureters and thence to the neck of the bladder is called the *trigone* or *bas fond* of the bladder. Its posterior limit is naturally defined by a slight ridge upon the mucous membrane, and occasionally the lateral also; the former is liable to become hypertrophied in old persons, in which case the concavity of the trigone appears to be much deeper. The outer wall of the bladder corresponding to the trigone rests directly upon the rectum, and has the two seminal vesicles and spermatic ducts upon its lateral boundaries. It is in this space that the operation of puncturing the bladder is sometimes performed.

The *Fibro-areolar Coat* does not differ in structure from the corresponding coat in the stomach and intestines.

The *Muscular Coat* consists of bands of pale involuntary fibres, crossing each other in every direction, and differing very greatly in size in different individuals. It is usually considered as consisting of an external and an internal layer, the fibres of the former encircling the organ horizontally, and those of the latter longitudinally; but this distinction cannot be made out clearly, except at the base, where the circular fibres are well marked, and at the commencement of the urethra form a distinct circular band or true sphincter muscle. From the neck the longitudinal fibres diverge in all directions, and are particularly well seen upon the base, along each side of which they sometimes form a separate band, leading from the neck to the extremity of the corresponding ureter, and hence called the *muscle of the ureter*.

Vessels and Nerves of the Bladder.—The *vesical arteries* are two upon each side, and very small; the *superior* is the remaining pervious portion of the hypogastric or umbilical artery, a branch of the internal iliac; the *inferior*, situated in front of and below the preceding, is also a branch of the internal iliac. The *veins*, which are numerous and large, form an intricate plexus around the neck of the organ, and terminate in the internal iliac veins. The *nerves* are derived from the hypogastric and sacral plexuses, those from the former source being distributed to the body of the organ, and those from the latter to the base and neck.

MALE ORGANS OF GENERATION.

The Male Organs of Generation are the testes and their excretory apparatus, and the penis, with the urethra and its appendages, the prostate and Cowper's glands. They will be here described in the order in which it is most convenient to examine them, upon the section of the pelvis already directed to be made.

THE PROSTATE GLAND.

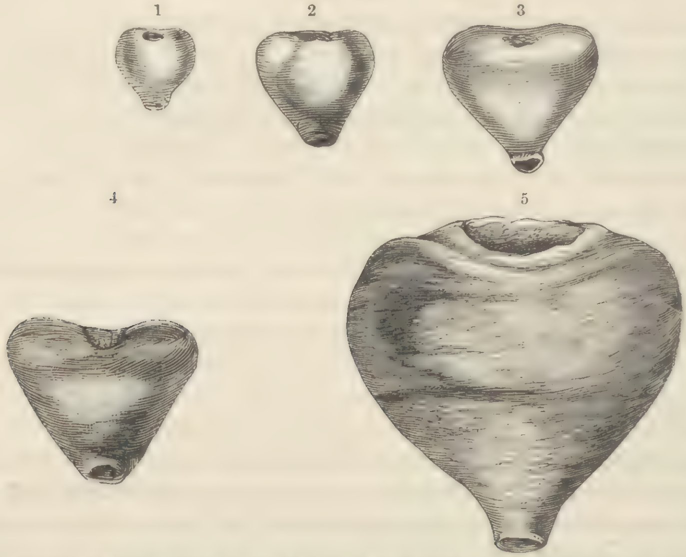
The Prostate Gland (Figs. 152 and 153) is situated somewhat more than half an inch below the highest point of the arch of the pubis, and surrounds the neck of the bladder and first portion of the urethra. It is a dense, whitish-looking organ, about the size and shape of an ordinary chestnut; it presents its base toward the bladder, and is directed from behind forward, and a little downward. In the adult it measures little more than an inch and a quarter in length, an inch and a half in breadth at its broadest part, and about three-fourths of an inch in thickness. Its *superior surface* looks upward and forward, is convex, traversed in the middle by a slight antero-posterior furrow, and connected to the back part of the pubic bones by the reflection of the pelvic fascia, forming the anterior true ligaments of the bladder. The *inferior surface*, almost flat, presents downward and a little backward, and rests upon the anterior surface of the lower extremity of the rectum, through which it can be readily felt with the finger. The two *borders* are thick and rounded and embraced by the anterior concave edge of the elevator muscle of the anus. The base is the broadest part of the organ and lies in contact with the bladder immediately around the neck, the pelvic fascia alone intervening. It presents a large perforation above for the urethra and two smaller ones below for the ejaculatory ducts. The *apex* is occupied entirely by the urethral opening, and rests against the thin posterior layer of the deep perineal fascia.

The prostate is considered as consisting of two *lateral lobes* united in the middle line by an isthmus, but the division is not generally well marked. Not unfrequently, however, the organ is notched at its base, in which case the inferior surface has the outline of a heart on playing cards. A third or *middle lobe* is also described by some anatomists as situated between the posterior rounded extremities of the lateral lobes,

but in a perfectly healthy organ no such lobe can be demonstrated. It is true that we sometimes find a nipplelike process of the gland projecting into the neck of the bladder, but this is rather due to a hypertrophied enlargement of the isthmus.

The prostate is traversed from base to apex by the first division of the urethra, and perforated obliquely from behind forward and upward by the ejaculatory ducts.

Fig. 153.



1. Prostate at birth. Width, at base, 4 lines; a little above middle, 5 lines; at apex, 2 lines; length along middle, 4 lines, and at edge, 4¾; thickness at base, 2 lines; at middle, 3¼, and at apex, 1¼. Weight, 13 grains.

2. Prostate at 4 years. Breadth, at base, 6 lines; just above middle, 7; and at apex, 2½; length along middle, 6 lines; and 7 lines at margin; thickness at base, 2¾ lines; at middle, 4; and at apex, 2. Weight, 23 grains.

3. Prostate at 12 years. Width, 8½ lines, at base; 9½ above middle, and 3 at apex; length, along middle, 8 lines, and 8½ at edge; thickness at base, 3; middle, 4½; and at apex, 2¾. Weight, 43 grains.

4. Prostate at 14 years. Width, at base, 11 lines; at middle, 9½; at apex, 4; length, along middle, 8 lines, and 10 at margin; thickness, 3½ at base, 5 at middle, and 3 at apex. Weight, 58 grains.

5. Prostate at 25 years. Width, at base, 18 lines; middle, 20; and apex, 5; length, along middle, 15 lines; and at edge, 18; thickness at base, 9 lines; middle, 10; at apex, 4. Weight, 4½ drachms.

Development.—The prostate does not attain its full size until some time after the age of puberty. The augmentation which it nearly always undergoes in advanced life is pathological, and is not therefore taken into account. The annexed representations, taken from a work* on the urinary organs, exhibit its size and form at five different ages.

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* Diseases and Injuries of the Urinary Bladder, etc., by S. D. Gross, Prof. of Surgery in the Jefferson Medical College.

Structure.—The prostate is closely invested by a thin but dense fibrous membrane, continuous in front with the posterior layer of the deep perineal fascia, behind with the pelvic fascia, and above with the anterior and lateral ligaments of the bladder. The proper tissue of the organ is of a grayish color and very firm consistence, and composed principally of organic muscular fibres and small racemose glands. The muscular fibres are longitudinal and circular, bound together by strong fibrous tissue, and bear a close resemblance in their arrangement to the proper tissue of the uterus. The glands are very small but very numerous, and are imbedded in the muscular tissue exterior to the canal of the urethra, into which they open by minute orifices. They are larger and more closely set in the lower than in the upper segment of the organ, and their open mouths give to this part of the urethra a finely punctured appearance.

The *arteries* of the prostate are small branches of the internal pudic, vesical, and hemorrhoidal. The *veins* open into the surrounding venous plexus. The *nerves* are offsets from the hypogastric plexus.

The secretion of the glands of the prostate is a clear, opaline, unctuous fluid, which when the parts are the seat of a chronic irritation is sufficiently abundant to simulate a gleet. Its use is unknown.

THE PENIS.

The Penis is situated in front of the pubes, and above the scrotum. When relaxed it is nearly cylindrical in shape, and curved with its concavity presenting downward; but in a state of erection, it is triangular prismatic, with its three angles rounded; and describes a very slight curve in an opposite direction. It is divided into three parts, the root, the body, and the head or glans; and consists essentially of a peculiar erectile tissue, in the form of two semicylindrical bodies (cavernous bodies), and one cylindrical body (spongy body). It is covered by skin and loose areolar tissue.

The *Skin* of the penis is very thin, and of a brownish hue, but lighter in color than that of the scrotum. It is attached to the subjacent parts by a loose areolar tissue, and prolonged over the glans or head in the form of a hood or sheath, called the foreskin or *prepuce*, which in many individuals is so long as to conceal this part of the organ entirely, but in others constitutes only a narrow rim surrounding the constriction or neck, immediately back of the head. The interior of the prepuce is lined by a thin mucous membrane, continuous with the skin at its free edge, and connected to it by remarkably loose areolar tissue, which is spread out when the skin is drawn back. From the inner surface of the prepuce the mucous membrane is prolonged upon the neck and head of the penis, in a still more attenuated form, and at the external orifice of the urethra is continuous with the lining membrane of this canal. Beneath the mouth

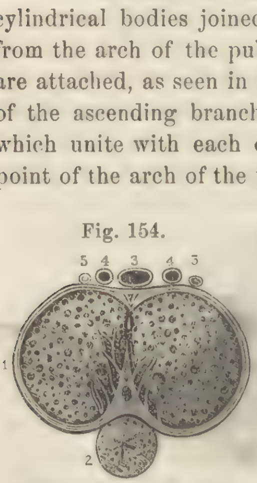
of the urethra it forms a vertical triangular fold, called the *bridle of the prepuce* (frænum præputii). In the substance of the mucous membrane behind the prominent border or *crown* (corona) of the glans, are quite a number of sebaceous glands or follicles, which secrete the offensively odorous white matter that collects in this situation in persons of uncleanly habits.

The *Subcutaneous Areolar Tissue* or superficial fascia of the penis is remarkably loose and open, and, like that of the eyelids and some other parts of the body, is never the seat of adipose deposit. It envelops the organ entirely as far forward as the head, and upon the upper surface of the root is collected into a large, loose, open band, called the *suspensory ligament* of the penis, which extends up the middle line of the anterior abdominal wall half way to the umbilicus.

Dissection.—Cut down upon the deep dorsal vein that lies in the groove between the two cavernous bodies upon the upper surface of the penis near the pubis, insert a blowpipe, and inflate the spongy body. If the valves of the vein prevent the passage of the air, they may be broken down with a probe or a stout broom-straw introduced from behind forward. Inflate also the cavernous bodies, the blowpipe being introduced into the root of the right, which has been already detached from its connection with the corresponding ischium. If convenient, however, it is much better to use some solid injection, such as wax or tallow. Next, dissect off the skin and superficial veins, so as to expose the cavernous and spongy structures.

The **Cavernous Bodies** (*corpora cavernosa*) (Fig. 154) are two semi-cylindrical bodies joined together by their flat surfaces, and extending from the arch of the pubes to the glans of the penis. Posteriorly, they are attached, as seen in the dissection of the perineum, to the inner edge of the ascending branches of the ischia, by two diverging legs or crura, which unite with each other about half an inch in front of the highest point of the arch of the pubis, and become, as it were, one body flattened from above downward, and grooved in the median line upon its superior and inferior surface. The superior groove is occupied by the superficial and deep veins and dorsal arteries of the penis, and the inferior, which is deeper, by the spongy body. The anterior extremities of the two bodies are slightly pointed, and closely connected to the base of the glans, but have no communication with the interior of the latter.

Fig. 154.



Transverse section through penis. 1, cavernous body; 2, spongy body; 3, dorsal vein; 4, 4, dorsal arteries; 5, 5, dorsal nerves.

Structure.—The cavernous bodies consist of a fibrous wall or coat, and an internal cavernous or erectile tissue. The *fibrous coat* forms a common investment for the two bodies; it is thick and strong, highly elastic up to a certain point, and composed of white tendinous-looking fibres that cross each other in every direction.

The *erectile tissue* consists: 1. Of fibrous bands, technically called

trabeculæ, crossing each other in every direction so as to inclose tolerably large interspaces. These bands are prolongations of the fibrous envelope and pectiniform septum. They vary in their shape and size, being in some places lamellar, in others cordlike, and in others mere threads. They cross each other in every direction and inclose irregular interstices, which communicate freely with one another in the same body, and with those of the opposite side through the slits of the pectiniform septum. 2. Of a venous plexus filling these interspaces. The *intertrabecular spaces* may be considered either as occupied by a venous plexus, or as forming so many divisions of a large cavernous sinus, lined by a continuation of the internal tunic of the veins supported by the fibrous bands. The veins with which they communicate pass out, for the most part, near the root of the penis, to join the large plexus around the prostate gland and base of the bladder, but quite a number emerge also by the side of the spongy body, and, winding around the sides of the penis, open into the dorsal veins. 3. Of arterial twigs ramifying within the substance of the trabeculæ, and upon them. The *arteries* of the cavernous bodies consist of two small branches of the internal pudics that enter the roots of these organs, and of offsets from the two dorsal arteries of the penis that run along the groove upon the upper surface. The twigs given off from these branches ramify throughout the cavernous structure, subdivide very minutely, and, having become capillary, terminate in the veins occupying the intertrabecular spaces. The exact disposition of these vessels, however, before they terminate in the veins, is not certainly known, although the description given by Müller seems most probable. According to this observer, the smallest ramifications of the arterial twigs, which he calls the "helicine arteries," leave the sides of the trabeculæ, project into the venous cavities covered by the lining membrane, and open by dilated extremities, some of which he describes as single, and some as forming tufts composed of minute subdivisions of a single projecting twig.

Examined upon a transverse section the two bodies are found to be separated by a median vertical plate of fibrous structure, which is thick and complete behind, but farther forward thin and open, consisting here only of vertical bands separated by slits of various sizes for free communication between the bodies; on account of its comblike appearance, it is called the *pectiniform septum*.

The **Spongy Body** (*corpus spongiosum*) (Fig. 149) occupies the inferior groove formed by the union of the two cavernous bodies, and is expanded over the anterior extremities of these organs to form the large head called the *glans penis*. Behind the glans, it is nearly cylindrical in shape and much smaller than the cavernous bodies, but at its posterior extremity it swells out to a considerable size, constituting, as already seen, the *bulb* of the penis. The bulb is situated beneath the angular

space formed by the divergence of the crura of the cavernous bodies, rests against the anterior surface of the triangular ligament, and is covered by the compressor muscle. The *glans penis* or head is conical in shape; its base presents backward and is closely attached to the anterior extremities of the cavernous bodies; its free surface is invested by mucous membrane and partially covered by the prepuce; and its rounded apex is perforated by the external slitlike orifice of the urethra. The base of the head is cut, as it were, obliquely from above downward and forward, and, its circumference being greater than that of the cavernous bodies, forms a projecting ridge called the *crown* (corona), behind which is a kind of groove or neck interrupted in the middle line below by the bridle of the prepuce.

The spongy body is traversed its whole length, from the bulb to the apex of the glans, by the canal of the urethra, as will be hereafter more particularly described.

Structure.—The spongy body is only a modification of the structure of the cavernous, the difference consisting in the greater thinness of its fibrous envelope, the finer quality of its trabeculæ, and the smaller size of its intertrabecular spaces. It has no communication with the cavernous bodies, and its veins terminate principally in the deep dorsal veins of the penis, a few smaller branches leaving the bulb to join the plexus around the prostate gland. Its arteries are: 1, the *arteries of the bulb*, one on each side, which leave the internal pudic in the triangular space between the anterior and posterior layers of the deep perineal fascia, enter the organ along with the membranous portion of the urethra, and are distributed nearly as far as the head; 2, the *dorsal arteries of the penis*, the two terminal branches of the internal pudics, which ascend through the triangular space formed by the divergence of the roots of the cavernous bodies, run along the sides of the groove upon the dorsal surface of the penis, sending twigs to the subjacent parts, and, having reached the neck of the organ, divide into several branches which enter the base of the head and ramify in its fine intertrabecular spaces.

The *lymphatics* of the penis are very numerous; they form an intricate network over the head of the organ and in the prepuce, and, passing backward upon the surface of the cavernous and spongy bodies, terminate in the inguinal lymphatic glands situated just above the inner third of the crural arch. They are most abundant in the prepuce and its frænum.

The *nerves* are numerous, and derived from the pudics and the hypogastric plexus of the sympathetic system.

THE URETHRA.

The Urethra, the excretory duct of the urine and spermatic fluid, extends from the neck of the bladder to the opening upon the head of the

penis, and in the flaccid state of this organ describes a double curve. The posterior division of the curve is short and permanent; it commences at the neck of the bladder and ends beneath the pubes, and presents its concavity upward and forward; the anterior is much longer, and looks downward and backward; but when the organ is in a state of erection, it is straightened out, or even bent slightly in an opposite direction. The length of the canal depends very much upon the state of the penis, and upon the manner in which the measurement is made. The average may be stated at eight or nine inches. Its diameter varies at different points, and cannot be accurately ascertained on account of the extensibility of its walls, but it is sufficient to state that a catheter, a quarter of an inch (about three lines) in diameter, readily passes the whole length of the canal in the adult, and that, by a process of gradual dilatation, it may be made to accommodate, without injury or inconvenience, an instrument twice the size. Its narrowest points are the external meatus and the membranous division, which are also the least dilatable portions.

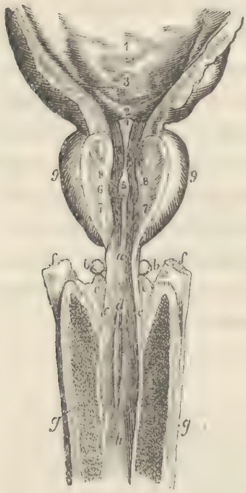
The urethra is divided into a prostatic, membranous, and spongy portion.

The **Prostatic Urethra** (Fig. 155) traverses the prostate gland from its base to its apex, somewhat nearer the upper than the lower surface of the organ. It is about an inch and a quarter (fifteen lines) in length, triangular prismatic rather than cylindrical in shape, wider at its middle than at either extremity, and, although surrounded on all sides by the firm tissue of the prostate, is the most dilatable part of the canal. Its direction corresponds to that of the axis of the prostate, which is forward and downward. When laid open, its lining mucous membrane will be found thrown into several longitudinal folds, all of them temporary, however, with the exception of the largest one, which forms a prominent ridge (Fig. 155, $_5$) along the floor of the passage, and is called the *urethral* or *gallinaginous crest* (caput gallinaginis, veru montanum). The crest is from seven to nine lines in length, about a line and a half in height at its highest point, and presents near its anterior extremity a very small pit called the *pocular sinus*, upon the sides of which may be seen the two minute orifices of the ejaculatory ducts. By means of the crest, the floor of the prostatic urethra is divided into two longitudinal depressions or grooves, named the *prostatic sinuses*, in which numerous ducts of the glands of the prostate terminate by small circular mouths.

The **Membranous Urethra** (Figs. 155, $_a$, and 152, $_5$), the narrowest part of the canal except the external orifice, extends, in the middle line of the perineum, from the apex of the prostate gland to the superior surface of the bulb of the spongy body. It is directed forward and very slightly upward, lies about one inch below the lower edge of the pubic symphysis, and traverses in its course, first the posterior layer of the deep

perineal fascia, then the narrow space between this and the anterior layer, and, lastly, just before terminating in the bulb, the anterior layer, called also, as frequently before mentioned, the triangular ligament of the urethra. Its superior surface is slightly concave, and measures about ten lines in length, but its inferior, owing to the oblique manner in which the anterior extremity terminates in the bulb, is three or four lines less. It is invested by a continuation of the anterior and posterior layers of the deep perineal fascia and the compressor muscle, and surrounded by an intricate plexus of veins. It is in the narrow space between the anterior and posterior layers of the deep perineal fascia that the canal is first reached in the lateral operation of lithotomy; the incision is then extended from the middle of the membranous portion obliquely backward into the prostatic portion, by dividing the left lobe of the gland to about one-half or two-thirds its extent.

Fig. 155.



Prostatic, membranous, and part of spongy portion of urethra, with part of bladder. 1, internal surface of bladder; 2, vesical trigone; 3, openings of ureters; 4, vesical uvula; 5, urethral or gallinaginous crest; 6, opening of pocular sinus; 7, 7, openings of ejaculatory ducts; 8, 8, openings of prostatic ducts; numbers 7, 7, and 8, 8, are placed on cut surface of supra-urethral portion of prostate gland; 9, 9, lateral lobes of prostate gland. *a*, membranous portion of urethra; *b*, *b*, Cowper's glands; *c*, *c*, mouths of ducts of same; *d*, commencement of spongy portion of urethra; *e*, *e*, upper surface of bulb; *f*, *f*, roots of cavernous bodies; *g*, *g*, cavernous bodies; *h*, spongy portion of urethra.

The **Spongy Urethra** commences in the centre of the bulb by a slight dilatation, called the *sinus of the bulb*, passes forward through the axis of the spongy body, and terminates upon the head of the organ in a vertical slitlike orifice, named the *external meatus* of the urethra. Its direction is generally curved with its concavity directed downward, but varies with the position and state of the penis. Its average length is from six to seven inches. Its diameter differs at different points; thus, in the bulb there is a slight dilatation, immediately in front of this a slight contraction, then a uniform size as far as the glans, in which there is a considerable dilatation, called the *navicular fossa*, and again immediately at the external meatus another contraction greater than at any other point in the whole canal. The communication of the spongy with the membranous portion of the urethra takes place upon the upper wall of the former immediately in front of the triangular ligament.

Structure of the Urethra.—The urethra is lined by a mucous membrane continuous with that of the bladder, ejaculatory ducts, and glans

penis. It is of a rosy color near the meatus, but a pinkish gray in the rest of its extent, thin, and rather easily torn, and, when the canal is contracted, thrown into numerous fine longitudinal folds, which, however, are obliterated during the passage of the urine or by the introduction of the catheter. It is provided with a spheroidal epithelium, and upon its surface may be seen the minute orifices of numerous racemose glands. One of the latter, much larger than the others, and situated upon the upper wall of the navicular fossa, is called the *lacuna magna*.

External to the mucous membrane is a layer of tolerably loose areolar tissue; next is a thin stratum of fibro-elastic tissue, the fibres of which are both longitudinal and circular; and lastly a layer of involuntary muscular fibre which extends throughout the whole length of the canal. In addition to these there is in the membranous division a fibrous envelope derived from the deep perineal fascia.

The lymphatics of the urethra form a close network in the submucous areolar tissue. They pass from behind forward and open into the lymphatic vessels of the glans penis.

Introduction of the Catheter.—As the student should neglect no opportunity to practice the introduction of the catheter upon the dead subject, a brief account of the mode of performing this operation may not prove out of place here.

Although a great many natural obstacles to the passage of the catheter into the bladder are enumerated in the various works on surgery, there is, anatomically considered, but one of any great importance. This is formed conjointly by the sinus of the bulb and the deep perineal fascia or triangular ligament. It is true, that if an instrument not larger than a common knitting-needle or probe is used, it may be caught in the open mouths of some of the urethral glands, particularly the large one upon the upper wall of the navicular fossa, or in the orifices of the ducts of Cowper's glands, if they should happen to be very large, which is but rarely if ever the case, or possibly in the pocular sinus of the gallinaginous crest; or, if a straight metallic instrument be employed, there might be some difficulty arising from the permanent nature of the first or smaller curvature of the canal, although even this with proper skill may be readily overcome. But with a metallic instrument, two or three lines in diameter, possessing the ordinary curve near its distal extremity, the only serious obstacle arising from the conformation of the parts is the one above mentioned (spasmodic contraction of the canal being, of course, excepted), and this is to be overcome by following the usual directions of practical surgeons.

Thus, the patient lying near the left edge of the bed on his back, with the legs and thighs flexed, and the latter separated, the operator takes the catheter near the extremity of its handle lightly between the thumb and first two fingers of his right hand, while with the left he raises the penis to a vertical line and puts it very slightly on the stretch. The handle being held parallel with and very near the abdomen in the median line, the point of the instrument is then introduced into the external orifice of the urethra, and carried down until it stops, the hand remaining in the same position. If there is no unnatural obstruction, the point will not be arrested until it reaches the bulb, which, when pressure is made, is forced against the triangular ligament or deep perineal fascia, and gives the feeling to the hand as if the instrument had reached the bottom of a resisting cavity. In order now to disengage the point from the sinus of the bulb, and to lodge it in the membranous portion of the canal, which, it will be remembered, opens upon the superior wall of the spongy urethra just in front of the sinus, the handle is raised from the horizontal to a vertical line, and, if necessary, depressed between the thighs, at the same time that very gentle pressure

is made in the natural direction. Having once entered the membranous urethra, the instrument passes on to the bladder without difficulty.

The common mistake that students and inexperienced physicians make, is to raise the handle from its horizontal position too soon, before the point reaches the bulb. But even when the above directions are fully carried out, difficulty is often experienced in getting the point into the membranous urethra, arising from causes that cannot always be explained, which, however, may be invariably overcome by gentle repetition of the trial and the exercise of a little patience.

THE TESTICLES AND THEIR EXCRETORY APPARATUS.

The two Testicles are suspended beneath the root of the penis by the spermatic cords, and inclosed by the scrotum and a serous membrane called the vaginal tunic or sac.

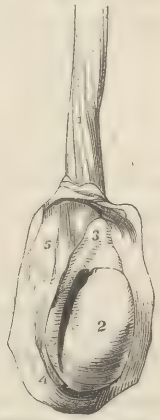
The **Scrotum** is a musculo-cutaneous bag, placed below the root of the penis to contain the testicles and the lower extremities of the spermatic cords. Its size differs in different individuals, and in the same person under different circumstances. It is contracted or drawn into a small firm ball under the influence of cold and certain states of the mind, and is long and pendulous, when relaxed by heat or other depressing causes. Its external or cutaneous layer is of a dusky brown color, very thin, and set with sebaceous follicles and long scattered hairs. Its surfaces are traversed from before backward by a well-marked median line or raphe, continuous with that of the perineum ; and, in the contracted state of the organ, it is folded on each side into numerous small wrinkles, most of which run transversely.

Beneath the skin is the *dartos* layer, a kind of musculo-areolar tissue, loose in its texture, of a pale reddish color, and very vascular. It is continuous with the superficial fascia of the perineum, attached on each side to the ramus of the ischium, and, in front, to the under surface of the back part of the penis. Its interior is divided into two lateral compartments by a middle wall or septum of the same tissue, and is loosely connected with the contained organs. Its external surface is closely attached to the skin, which, being very thin, allows the numerous veins that ramify in its substance to be seen through it. Its fibres cross each other in every direction and belong to the class of involuntary or unstriped muscle. By its contraction, which is independent of that of the cremaster muscle, the testicles are slightly compressed and drawn up to the root of the penis. Within the dartos is a layer of open areolar tissue, continuous with the spermatic or intercolumnar fascia of the spermatic cord. Next within this are a few scattered fibres of the cremaster muscle, which, coming from the crural arch in connection with the lowermost fibres of the internal oblique muscle of the abdomen, descend upon the outer side of the cord, and, forming loops around the vaginal tunic, return to be inserted into the body of the pubic bone.

Vessels and Nerves of the Scrotum.—The *Arteries* that supply the scrotum are the two external pudics, a branch from the superficial perineal, and several small twigs from the cremasteric. The *external pudics*, quite small, are branches of the femoral artery, which they leave at the saphenous opening, and, passing transversely across the lowest part of the groin, supply the skin and dartos of the anterior part of the scrotum. The *superficial perineal* is a branch of the internal pudic, and, after supplying the skin of the perineum, is distributed to the back part of the scrotum. The *cremasteric* is a small offset from the epigastric; it descends upon the spermatic cord to supply the cremaster muscle, and sends minute twigs to the dartos and skin of the scrotum. The *Veins* follow the course of the arteries. The *Lymphatics* are few and scattered, and terminate in the glands of the groin.

The *Nerves* are: 1, the scrotal branch of the ilio-lumbar (a branch of the lumbar plexus), which passes out at the external abdominal ring and is distributed to the skin of the scrotum; 2, branches from the two superficial perineal nerves, derived from the internal pudic; 3, the inferior pudendal, a slender twig from the small sciatic that joins the preceding; and 4, the genital branch of the genito-crural, which leaves the abdomen through the inguinal canal, and, having supplied the cremaster muscle, sends filaments to the vaginal tunic and its coverings.

Fig. 156.



Testicle, and part of spermatic cord, with vaginal tunic laid open. 1, lower part of spermatic cord; 2, body of testicle; 3, 4, epididymis; 3, globus major or head; 4, globus minor or tail; 5, internal surface of vaginal tunic.

Removing the fibres of the cremaster muscle, which constitutes what is technically called the *tunica erythroïdes* of the testicle, and dissecting off a thin layer of fascia continuous with the tubular or transverse fascia of the cord, the vaginal tunic will be brought into view.

The **Vaginal Tunic of the Testicle** is a serous sac, which lines the interior of each lateral half of the scrotum, and invests the contained organ. Its *parietal layer* is covered externally by a continuation of the tubular or transverse fascia of the spermatic cord and the scattered fibres of the cremaster muscle, and connected to the internal surface of the dartos by loose areolar tissue continuous with the spermatic or intercolumnar fascia of the cord. The *visceral layer* invests the lower extremity of the spermatic cord and the whole of the body of the testicle, except a narrow space along the posterior border of the organ where the vessels enter and emerge. It is pushed in, as it were, between the middle of the epididymis and the body of the gland, in the form of a

little pouch on each side, and covers the lateral surfaces of the epididymis, and, at the posterior border of the latter, is continuous with the parietal or reflected layer. The connection between the visceral layer and the fibrous or proper coat of the body of the testicle is by close, strong, areolar tissue.

The internal surface of the vaginal tunic is smooth and polished, always in contact with itself, and exhales, for the purpose of lubrication, a very small quantity of thin serous fluid, which, when unnaturally copious, constitutes the disease called hydrocele.

The vaginal sac is originally derived from the peritoneum, being a mere prolongation of the latter membrane, generally described as carried down through the inguinal canal into the scrotum by the testis. A narrow, tubular communication, therefore, exists between the two immediately after the testicle reaches its place, but within a short time the serous tube is obliterated or converted into a fibro-areolar cord, and the vaginal tunic is then an independent sac. Occasionally, a coil of intestine follows close after the testis in its descent, thus preventing the occlusion of the tube, and constitutes what is known as congenital hernia, the vaginal tunic, in this case, being substituted for the proper hernial sac. Not unfrequently the fibrous band into which the tube is converted may be found in the adult lying in front of the spermatic vessels, covered by the intercolumnar fascia, cremaster muscle, and tubular fascia, and attached to the upper extremity of the vaginal sac.

The **Testicles**, the two glands that secrete the spermatic or seminal fluid, hang suspended in the cavity of the scrotum by the spermatic cords, but not upon the same level, the left being a little the lower. Their number seldom varies, although they are not always found in the scrotum. Sometimes one or the other, or occasionally both, remain in the abdomen or in the inguinal canal, and in one instance that came under the author's observation the left was situated between the external and internal oblique muscles of the abdomen, about two inches above the crural arch, having gained this position by passing down the inguinal canal, and then turning upward instead of going out at the external ring. They are oval, but slightly flattened in a lateral direction, and are connected to the spermatic cord in such a manner that their long axes are directed from above downward and backward. They generally measure nearly an inch and a half in length, three-quarters of an inch in thickness, and an inch from the anterior to the posterior border. Their weight varies from four to eight drachms each.

Structure.—The structures composing each testicle are a fibrous envelope, called the albugineous coat, a vascular membrane, and a proper or tubular tissue.

The *Albugineous* or *Fibrous Coat* forms a complete envelope for the

organ, is of a bluish-white color, dense and unyielding, and consists of white glistening fibres, closely interlacing each other in every direction. It is invested externally by the visceral layer of the vaginal sac, except along the posterior border, where it is perforated by the vessels, nerves, and efferent ducts. From its internal surface, opposite the upper part of the posterior border, it sends a short, flattened process downward and forward, which forms an imperfect median septum or partition, called the *mediastinum* or *body of Highmore* (corpus Highmorianum). This septum is perforated by the bloodvessels and ducts, and from its border and lateral surfaces numerous fibrous cords or *trabeculæ* pass to all points of the inner surface, and divide the inclosed space into as many separate compartments for the lodgment of the tubular substance. Lining the internal surface of the albugineous tunic, and the several compartments formed by the trabeculæ, is an exceedingly delicate network of arteries and veins, held together by fine areolar tissue, and described by Sir Astley Cooper, its discoverer, as the *vascular tunic* (tunica vasculosa, Fig. 157, 4).

Fig. 157.

Transverse section of testicle. 1, cavity of vaginal tunic; 2, albugineous tunic; 3, mediastinum giving off numerous fibrous cords in radiated direction to internal surface of albugineous tunic; cut extremities of vessels below the number belong to rete, and those above to arteries and veins of organ; 4, vascular tunic; 5, lobule, consisting of convolutions of seminiferous tubules, and terminating by single duct; corresponding lobules are seen between other fibrous cords of mediastinum; 6, section of epididymis.

The *Tubular* or *Proper Tissue* of the testicle occupies the cavities formed by the trabeculæ, and is consequently divided into as many small masses called *lobules.* The *lobules* (Fig. 158, 1, 1) are conoidal in shape, and have their apices directed toward the posterior border of the organ, and their bases toward its circumference. Their number is variously stated by authors at from 250 to 400. Their size corresponds to that of the cavities in which they are contained, those running antero-posteriorly being consequently the longest. Each lobule consists of one or two minute tubes called *seminiferous tubules*, coiled upon themselves a great many times, and connected to the surrounding parts by vessels from the vascular tunic, and by a small quantity of delicate fibrous tissue, continuous with the trabeculæ. The length of each tubule, when unraveled, is nearly sixteen feet, and of all of them together, according to Monro, more than five thousand feet, or about a mile. Their diameter is about $\frac{1}{200}$ of an inch.

The seminiferous tubules commence either in blind extremities or loops, and, having become coiled up as above mentioned, leave the apices of the cones or lobules behind in a straight direction, and enter the body of

Highmore, where they form a network termed the *tubular rete.* In this network, which is situated along the posterior border of the organ in the substance of the mediastinum, the tubes unite with one another to form fifteen or twenty common ducts called the *efferent ducts*, which perforate the albugineous tunic at its upper back part, and, becoming coiled upon themselves, once more constitute a prominent mass, named the head of the epididymis (Fig. 158, $_{5,5}$).

The **Epididymis** (Fig. 158, $_{5,6}$) is a prominent, elongated body, flattened from side to side, situated along the posterior border of the body of the testicle, and covered upon its lateral surfaces by the visceral layer of the vaginal sac. Its superior extremity, called the *head* or *greater globe* (globus major), rises from the superior part of the posterior border of the testicle, becomes somewhat expanded, and when viewed laterally looks a little like the crest of an ancient helmet. Below the head, it is contracted and narrow, and separated from the body of the testicle by a prolongation of the vaginal tunic; but at the lower extremity, the *tail* or *smaller globe*, it becomes again enlarged, but not to the same size as above, is attached to the lower part of the posterior border of the gland by the vaginal tunic, and descends a little lower to become continuous with the seminal or deferential tube.

Fig. 158.

Testicle injected with mercury and divested of its albugineous tunic. 1, 1, lobules formed by seminiferous tubules; 2, tubular rete; 3, 4, vascular cones formed by seminiferous tubes; 5, 6, epididymis; 7, aberrant duct; 8, termination of epididymis in 9, 9, deferential tube.

Structure. — Beneath the vaginal tunic that invests the lateral surfaces of the epididymis is an exceedingly thin fibrous expansion, continuous with the albugineous tunic. The proper tissue of the epididymis, inclosed by this expansion, is essentially the same as that of the body of the testicle, and is arranged in the following manner: The efferent ducts derived from the tubular rete, fifteen or twenty in number, and about $\frac{1}{80}$ of an inch in diameter, all perforate the albugineous coat upon the upper back part of the testicle, then diverge from one another, and become separately coiled into as many little *tubular cones* [3 4] (coni

vasculosi), from six to eight lines in length, the bases of which form the free border of the greater globe. Along this border the tubes from the several cones successively unite, from above downward, to form a single duct, called the *canal of the epididymis*, which, coiled many times upon itself, constitutes the remaining part of the epididymis.

From the tail or smaller globe, the canal is gradually unraveled, turns upward, and, ascending along the posterior border of the organ, takes the name of the *seminal duct* or *deferential tube* (vas deferens). The length of each tube composing the cones of the greater globe is six or eight inches; their diameter, however, gradually decreases from the time they leave the testicle, so that the coiled portion of the common duct or canal of the epididymis, which they unite to form, is but little larger than the first part of one of these efferential ducts. The length of this canal, when uncoiled, is over twenty feet; its diameter, at first about $\frac{1}{70}$ of an inch, becomes even less in the tail of the epididymis, but again enlarges toward the commencement of the deferential tube.

The walls of the seminiferous tubules and efferential ducts consist of three coats, an *external*, of a grayish semitransparent appearance, possessed of considerable strength and elasticity, and formed of fibro-elastic tissue; a *middle*, composed of basement membrane; and an *internal*, a delicate tesselated epithelium, whose cells, besides a nucleus, contain a granular substance, which upon escaping is transformed into spermatozoa.

The canal of the epididymis is provided with involuntary muscular fibres beneath the fibrous coat, and its epithelium is said to be columnar.

The **Deferential Tube** (*vas deferens, seminal duct*) is the continuation of the canal of the epididymis. Commencing at the tail of the epididymis, it makes a short turn and ascends in a serpentine manner along the posterior border of the organ, but is separated from it by the bloodvessels of the testicle. Opposite the greater globe it becomes straight, enters the spermatic cord, and ascends in connection with the spermatic artery and veins to the external abdominal ring, and through the inguinal canal; at the internal ring it leaves the spermatic vessels, turns suddenly downward and inward beneath the peritoneum and around the epigastric artery, crosses the external iliac vessels, and, having gained the side of the bladder, curves over toward the base of this organ, which it reaches upon the inner side of the entrance of the ureter. At the base of the bladder it is directed forward and inward along the inner side of the corresponding seminal vesicle, approaching its fellow of the opposite side, and, having nearly reached the base of the prostate gland, unites with the duct from the vesicle to form the common seminal or ejaculatory duct, which perforates the prostate, and opens separately from its opposite

fellow by a minute orifice upon the side of the little recess called the pocular sinus, formed upon the summit of the urethral or gallinaginous crest.

It is cylindrical, and so firm and hard that it may be easily felt through the skin, and pressed away from the other constituents of the spermatic cord. Its length is nearly two feet, and its diameter not more than $\frac{1}{10}$ of an inch, except two inches of its terminal extremity, which are considerably enlarged and sacculated. The diameter of its canal is not more than one-fourth of a line, but its walls are dense and strong, and about one-third of a line thick, except at the dilated part, where they are thinner and the canal correspondingly larger.

The deferential tube is composed of a thick layer of fibrous tissue, a layer of involuntary muscular fibres, and a lining mucous membrane. The latter is of a pale color, marked by numerous fine longitudinal ridges, and covered by a pavement epithelium. In the dilated portion there are, in addition to the longitudinal ridges, transverse folds which give to the surface a sacculated appearance.

The *Aberrant Duct* (vas aberrans) (Fig. 158, $_7$) is a narrow blind tube about three inches long, situated among the structures of the lower part of the spermatic cord, and extending in a tortuous manner along the posterior border of the epididymis to the commencement of the deferential tube. Its superior extremity is closed, but below it communicates with the canal of the deferential tube, of which, in fact, it is a mere diverticulum. It is frequently wanting.

The **Seminal Vesicles** (*vesiculæ seminales*) (Fig. 152) are two oblong membranous reservoirs for the seminal fluid, situated upon the under surface of the base of the bladder, and extending from near the terminations of the ureters, along the outer boundaries of the vesical trigone to the base of the prostate gland. They are about two inches long, half an inch broad, and separated from each other about an inch and a half at their posterior extremities; but they converge from behind forward, and terminate anteriorly in a small duct, which joins the deferential tube to form the ejaculatory or common seminal duct. They are closely connected to the bladder by a reflection of the pelvic fascia, and are in relation behind with the anterior surface of the rectum. The deferential tubes pass along their inner border.

When the fibrous covering, which the seminal vesicles derive from the pelvic fascia, is removed, they present the appearance of convolutions. These may be dissected apart, and each sac will be then found to consist of a membranous tube four to six inches long, and about a quarter of an inch in diameter, many times folded upon itself, and terminating posteriorly in a blind extremity, near which may sometimes be seen one or

more diverticula passing off to the distance of an inch or two, and ending in the same manner.

The *duct* of each seminal vesicle proceeds from the anterior extremity of the organ; it is short and narrow, and joins the deferential tube, near the base of the prostate gland. The *common seminal* or *ejaculatory duct*, formed by this union, enters the back part of the prostate gland, runs forward and upward, approaches its opposite fellow, and the two, lying side by side, open by small separate orifices in the prostatic portion of the urethra, either in the bottom or upon the sides of the pocular sinus, the little depression situated upon the summit of the gallinaginous crest.

Structure.—The structure of the seminal vesicles is similar to that of the deferential tube, but their caliber is much greater, and the lining mucous membrane is marked by numerous delicate ridges, inclosing small interspaces like those found upon the interior of the gall bladder, but much finer. Its epithelium is squamous.

Vessels and Nerves of the Testicles and their Excretory Apparatus.—The special *artery* of the testicle is the *spermatic*, which originates from the abdominal aorta and descends behind the peritoneum to the internal abdominal ring, and then through the inguinal canal, forming one of the constituents of the spermatic cord. Near the testicle it divides into numerous twigs, some of which are distributed to the epididymis, but most of them perforate the albugineous coat along the posterior border of the organ, and form that delicate network called the vascular tunic. From this network minute offsets proceed along the fibrous beams (trabeculæ), to be distributed to the seminiferous tubules. The deferential tube is supplied by a very remarkable delicate arterial twig called the *deferential artery*, which comes from the superior vesical, a branch of the internal iliac, and follows the tube from the pelvis as far as the testicle. The seminal vesicles receive arterial twigs from the vesical arteries, which are accompanied by corresponding veins.

The *spermatic veins* leave the testicle and epididymis by the side of the corresponding branches of the spermatic artery, ascend the spermatic cord in a very tortuous manner, and, gradually uniting with one another, form two main trunks, which enter the abdomen through the inguinal passages, and in their turn unite to form a single trunk. The right opens into the ascending cava, and the left into the renal vein of the same side. They are very liable to become enlarged and varicose, particularly those of the left side, constituting the disease known as varicocele.

The *lymphatics* of the testicles accompany the spermatic artery and vein, and terminate in the lymphatic glands in the lumbar region of the abdomen.

The *nerves* of the testicle are for the most part branches of the hypogastric plexus, and belong therefore to the sympathetic system, but that it also receives filaments from the cerebro-spinal system is amply proved by the great pain experienced when the organ is severely pressed or otherwise injured. The nerves of the seminal vesicles are derived from the hypogastric plexus.

The student should next proceed to the dissection of the vessels and nerves of the pelvic cavity, the description of which he will find at the close of the account of the "Female Organs of Generation."

FEMALE ORGANS OF GENERATION

AND

ASSOCIATE PARTS.*

THE Generative Organs of the Female are commonly divided into the external and internal: the external comprising a number of parts under the general name of vulva; the internal, the vagina, uterus, Fallopian tubes, and ovaries. The former should first be examined. The interior of the pelvis of the female, and the vessels and nerves of the pelvic cavity, may also be described in connection with these structures.

EXTERNAL ORGANS OF GENERATION.

The Vulva.—This term, in its general acceptation, comprises all the external female organs of generation, seen in an ordinary examination when the thighs are widely separated. The principal divisions are the mons veneris, labia, clitoris, nymphæ, and perineum.

The *Mons Veneris* is the rounded eminence situated in front of the pubes, above the genital fissure, and covered in the adult with hair. The elevation is due in part to the projection of the bones at the pubic symphysis, but mainly to a thick layer of subcutaneous adipose substance, remarkable for its density, and intimate attachment to the subjacent parts.

The *Labia* (labia majora) are the two large, rounded folds of integument, that form the margins or lips of the genital fissure. They are thick and prominent in front, but become thinner as they pass backward, and unite in front of the perineum by a little crescentic fold, called the *posterior commissure* or the *fourchette*, which is generally lacerated in first parturitions. The outer surface of each lip is formed by integument continuous with that of the thighs, and is covered with hair; the internal is more of a mucous nature, smooth and moist, and in contact with that of

* If the subject which the student is engaged in dissecting is a male, he may pass over this section, and proceed to the dissection of the vessels and nerves of the pelvic cavity.

the opposite side. Inclosed between the cutaneous and mucous coverings, and forming the internal structure of the labia, are a quantity of firm adipose substance, a few fibres of yellow elastic tissue, and numerous small vessels and nerves. Within the posterior commissure, and in front of the commencement of the vagina, is a smooth surface slightly excavated, named the *navicular fossa.*

Situated upon the inner surface of the labia are two smaller folds, the *Nymphæ* (labia minora, Fig. 159, $_{10}$), formed of mucous membrane, inclosing a little erectile tissue. They commence within the anterior angle of the genital fissure by two delicate folds, situated one in front of, and the other behind the clitoris; they descend backward, become quite broad, and gradually subside or spread out upon the mucous surface of the labia. They vary greatly in size in different individuals, and are relatively larger in infants than in adults. In some of the African races, particularly the Hottentots, they are said to attain an enormous magnitude, hanging down in front of the thighs like an apron.

Fig. 159.*

Section of female pelvis, from before backward. 1, sacrum; 2, coccyx; 3, pubic symphysis; 4, rectum; 5, one of its valvular folds; 6, anus; 7, uterus; 8, vagina; 9, right labium; 10, right nympha; 11, clitoris, attached by suspensory ligament to front of pubic symphysis; 12, glans; 13, prepuce; 14, urethra; 15, entrance of vagina; 16, bladder.

The *Clitoris* is a small reddish-looking process, very much like the uvula, situated about half an inch within, and concealed by the anterior

* The recto-vaginal reflection of the peritoneum descends a little lower than is represented in the figure.

junction or commissure of the labia, and inclosed by the two commencing folds of the nymphæ, which sometimes form a partial covering or prepuce for it. It is the homologue of the penis, and consists of two small cavernous bodies placed side by side, and attached to the rami of the pubes by corresponding divergent roots or crura, which are covered by a small muscle called the *erector of the clitoris.* Its internal structure is precisely similar to that of the cavernous bodies of the penis, and possesses erectile properties. Its external surface is covered by mucous membrane, which is remarkably sensitive. In addition to its cavernous bodies, it is said to possess also a structure at its free extremity beneath the mucous membrane, analogous to the glans or head of the penis, except that it is not perforated by the urethra.

About half an inch behind the clitoris, and just in front of the projecting ridge formed by the commencement of the vagina, is the *external orifice of the urethra.* Its circumference is slightly raised and puckered, but the orifice itself is a little depressed. It is small, always closed except during micturition, and, if a probe is introduced, will be found to lead upward and backward. Upon each side of the opening may be seen a minute foramen, which is the mouth of a small duct, coming from the corresponding gland of Bartholine, hereafter to be examined. The smooth space between the external orifice of the urethra and the clitoris is called the *vestibule.*

By separating the labia, the mouth or *entrance of the vagina* will be brought into view. It is large, oval in an antero-posterior direction, and. in the virgin, is occupied and partially closed by a delicate crescentic or circular fold of the mucous membrane, called the *hymen.* The development of the hymen differs in different individuals, and is sometimes almost entirely wanting. Its existence is not positive evidence of virginity, as it is not always ruptured by coition, much less is its absence any evidence to the contrary. It is generally weak, however, and easily ruptured, and hence readily gives way in the first coition; but its original situation is marked by numerous little wartlike eminences called the *myrtiform caruncles.*

Vessels and Nerves of the Vulva.—The mons veneris and labia are supplied with blood by the two *external pudic arteries*, which come from the femoral just below the crural arch. The deeper parts receive branches from the *internal pudic* on each side.

The *veins* are very numerous, and constitute, upon the sides of the commencement of the vagina, the two erectile masses or *bulbs* to be presently described, which, with a comparatively large trunk upon the anterior surface of the clitoris, called the *dorsal vein* of this organ, pass backward to the vaginal plexus, and ultimately terminate in the internal iliac veins. The *obturator vein* collects the blood by numerous anastomosing branches from the mons veneris and labia, and passing backward and outward through the obturator foramen terminates in the internal iliac.

The *nerves* of the vulva are branches of the hypogastric plexus which accompany the bloodvessels. It also receives filaments from the genitocrural and fourth lumbar nerve, the latter being distributed to the mons veneris and labia, and from the internal pudic, which last sends a considerable branch to the clitoris.

The *lymphatics* accompany the vessels and terminate in the inguinal and lumbar glands.

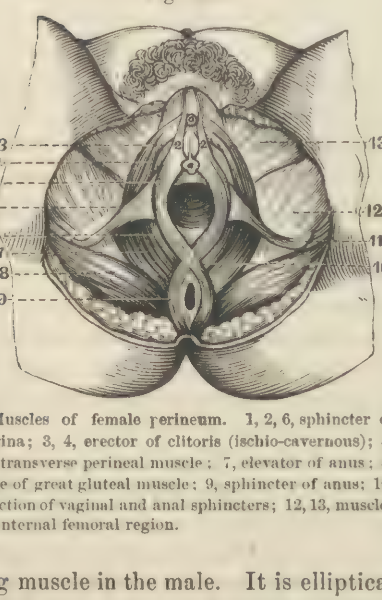
THE PERINEUM.

The Perineum in the Female is a pyramidal or wedge-shaped space, situated between the lower extremity of the vagina and the rectum, and occupied principally by areolar tissue, fat, and bloodvessels. Its base (to which alone students are apt to think the name "perineum" is limited) separates the vulva from the anus, is covered by smooth skin, and measures about an inch in an antero-posterior direction. The term *posterior perineum* is sometimes applied to the space between the anus and coccyx.

Dissection.—Remove the skin and subjacent adipose substance forming the labia, and from the perineum as far back as the point of the coccyx, and the following muscles will be brought into view.

The **Sphincter of the Vagina** (Fig. 160, 1, 2, 6) is an elliptical muscle surrounding the commencement of the vagina, and consists of two lateral halves, which unite, *behind*, in the median raphe of the perineum, and, *in front*, upon the sides of the clitoris and lower part of the pubic symphysis.

Fig. 160.



Muscles of female perineum. 1, 2, 6, sphincter of vagina; 3, 4, erector of clitoris (ischio-cavernous); 5, 11, transverse perineal muscle; 7, elevator of anus; 8, edge of great gluteal muscle; 9, sphincter of anus; 10, junction of vaginal and anal sphincters; 12, 13, muscles of internal femoral region.

The **Transverse Perineal Muscle** (Fig. 160, 5), small, indistinct, and often wanting, arises on each side from the corresponding ramus of the ischium, and is inserted into the side of the sphincter of the vagina.

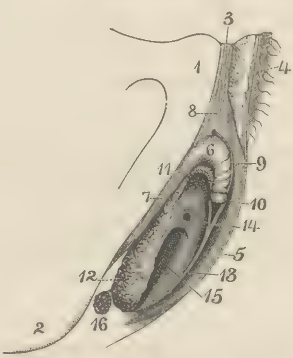
The **Sphincter of the Anus** is not unlike the sphincter of the vagina, only smaller, and precisely similar to the corresponding muscle in the male. It is elliptical, and consists of two lateral halves, which are continuous in front with the posterior extremity of the sphincter of the vagina, and attached behind to the point of the coccyx.

Dissection.—Remove the two sphincters and the transverse perineal muscles, and the lower surface of the elevator muscle of the anus and the erectile tissue of the vagina, called the bulbs of the vagina, will be brought into view.

The **Elevator Muscle of the Anus** is like that found in the male, except that, besides being inserted into the side of the lower extremity of the rectum, it is also inserted into the side of the commencement of the vagina.

The **Bulbs of the Vagina** are two elongated oval-shaped bodies, about an inch in length, consisting of a network of veins inclosed in a fibrous envelope, and situated one on each side of the commencement of the vagina. They are each attached above by a pointed extremity to the corresponding root of the clitoris and ramus of the pubis, covered internally by the mucous membrane lining the sides of the vulva behind the nympha, and embraced externally by the sphincter of the vagina. They are considered as analogous to the bulbous portion of the penis, and communicate with nearly all the surrounding veins, especially the vaginal plexus, and dorsal vein of the clitoris.

Fig. 161.



External organs of generation. 1, right pubis; 2, tuberosity of ischium; 3, symphysis of pubes; 4, left half of mons veneris; 5, left labium; 6, clitoris; 7, crus of right cavernous body; 8, suspensory ligament; 9, dorsal vein; 10, glans; 11, pedicle of right half of spongy body; 12, right half of bulb; 13, left nympha, terminating above in prepuce; 14, urethral orifice at base of vestibule; 15, vagina; 16, right suburethral gland.

The **Glands of Bartholine** are two reddish-looking bodies about the size of a small bean, situated one upon each side of the commencement of the vagina behind the inferior extremities of its bulbs, and between the mucous membrane and ischio-cavernous muscles of the clitoris. They are analogous to Cowper's glands in the male, and each is provided with a long narrow duct, which opens upon the mucous membrane behind the upper extremities of the nymphæ, near the orifice of the urethra. They secrete a mucuslike fluid, especially during venereal excitement, and become atrophied in advanced age.

INTERIOR OF THE PELVIS.

Dissection.—Dissect the soft parts from their connections with the ramus of the ischium and the pubis of the right side, cut through the pubic symphysis, detach the organs of the pelvis from the right wall of this cavity and push them over to the left; next, divide the right common iliac vessels, sacral plexus of nerves, pyriform muscle, and corresponding sacro-ischiatic ligament, and, by

forcibly separating the thighs, tear the right ilium from the sacrum. The object of this procedure is to get a profile view of the pelvic organs, which are thus left in the concavity formed by the sacrum and left innominate bone.

Trim the loose ends of the muscles, skin, and other structures from the side of the section, and, having sponged the parts, examine the disposition of the pelvic portion of the peritoneum.

The **Peritoneum** (Fig. 159) descends from the posterior wall of the abdomen, upon the front and sides of the rectum, to within three or four inches of the anus, is then reflected forward to the back part of the vagina, the upper third of which it covers, and thence ascends upon the corresponding surface of the neck and body of the uterus. From the fundus of the uterus it is continued down upon its anterior surface as low as the neck; here it passes forward to the bladder, the posterior surface and summit of which it invests, and reaches the anterior wall of the abdomen just above the pubes. From the sides of the uterus, it is reflected off to the lateral walls of the pelvis in the form of two large vertical folds, called the *broad ligaments*, which are each divided above into three minor folds, diverging from the superior angle of the uterus, the *anterior* fold inclosing the round ligament of the uterus; the *middle*, the Fallopian tube; and the *posterior*, the ovary.

Dissection.—Remove the peritoneum from the left lateral wall of the pelvis, and the *pelvic fascia* will be found disposed very much as it is in the male. Its vertical layer, however, after covering the superior surface of the elevator muscles of the anus, is reflected upon the exterior of the vagina as well as upon the neck of the bladder. Remove this layer of the fascia, and the *elevator of the anus* will be found to correspond to that in the male in every particular, except that between the neck of the bladder and the rectum it is inserted into the lateral wall of the vagina. Next, examine the direction and relations of the rectum and bladder, and then the internal organs of generation.

The **Rectum** follows the same course as in the male, but its relations are different. Thus, it is here separated from the posterior surface of the uterus and upper third of the vagina by the posterior *cul-de-sac* of the peritoneum, which often contains a coil or two of intestine. Below the reflection of the peritoneum it is in immediate apposition with the vagina for the distance of about an inch and a half, the junction of the walls of the two cavities constituting the *recto-vaginal septum.* In the lower third of its course it turns a little backward, leaving a wedge-shaped space between it and the vagina, which is occupied principally by areolar and adipose tissue, and constitutes the perineum.

The **Bladder** (Fig. 159) in the female is situated between the uterus and vagina behind and the pubes in front, and, on account of the comparative narrowness of the interval between these parts, is flattened antero-posteriorly, so that its transverse diameter is the greatest; but if dissected from its attachments and inflated, it becomes ovoidal, with its axis directed downward and backward. Its anterior and lateral surfaces

and summit correspond to the same parts as in the male, but its posterior surface, covered throughout with peritoneum, is in relation with the anterior surface of the uterus; its base is connected by areolar tissue to the upper part of the anterior wall of the vagina. Its structure is the same as in the male.

The **Urethra** in the female is simply a continuation of the neck of the bladder. It is about an inch and a half long, commences in front of the base of the bladder, passes downward and forward beneath the pubic symphysis, and is imbedded in the anterior wall of the vagina. It perforates the deep perineal fascia or triangular ligament, and opens within the vulva just in front of the projecting edge of the commencement of the vagina, and about half an inch below and behind the clitoris. It is somewhat curved in its course, the concavity presenting upward and forward, and is held in its position by the reflection of the pelvic fascia forming the anterior ligaments of the bladder, by the deep perineal fascia, and by its connection with the vagina. It consists externally of condensed areolar tissue and plexiform veins, surrounded by muscular fibres similar to the compressor muscle of the membranous portion of the male urethra; and, internally, of a mucous membrane continuous with that of the bladder. In its ordinary state, it readily admits an instrument two or three lines in diameter, and is remarkable for its great dilatability.

INTERNAL ORGANS OF GENERATION.

The Internal Generative Organs are the vagina, uterus, Fallopian tubes, and ovaries.

THE VAGINA.

The Vagina (Fig. 159) is the membranous canal extending from the vulva to the uterus, and serves for the passage of the menstrual fluid and the fœtus. It is situated mostly within the cavity of the pelvis, the axis of the lower part of which it accurately follows, and is, therefore, directed from the uterus downward and forward, describing a curve with the concavity presenting upward and forward. In consequence of its curved form, its length is greater along its posterior than its anterior wall, the former measuring five or six inches, and the latter only about four. It is cylindrical when distended, but in its ordinary empty condition its anterior and posterior walls are in contact. Owing to this fact, and its great dilatability, it cannot be said to have any fixed diameter; but its entrance or commencement is the narrowest part.

Relations.—The vagina is in immediate relation, in front, with the base of the bladder, the junction between the two constituting the *vesico-vaginal septum.* The septum is composed, therefore, of the walls of the two cavities and the intervening layer of areolar tissue: it is shaped

somewhat like a heart on playing cards, with its base presenting backward, and lodging the anterior half of the neck of the uterus. Below the septum, the lower half of the urethra is imbedded in the anterior wall of the vagina.

Posteriorly the vagina is separated from the rectum in the upper fourth of its extent by the recto-vaginal pouch of the peritoneum; below which the two canals are in close contact for the distance of an inch and a half, forming the *recto-vaginal septum:* in its lower third it is separated from the rectum by the perineum.

Laterally, it is connected for a little way to the lower edge of the broad ligament of the uterus, below which it gives insertion to the elevator muscle, and still lower is surrounded by areolar adipose tissue and a large plexus of veins.

The superior extremity of the vagina embraces the lower part of the neck of the uterus, which projects into it. Its attachment behind is somewhat higher up than in front, so that the circular trench between the two is not of the same depth at all points. The inferior extremity or mouth of the vagina has been already described in connection with the vulva (p. 331).

Structure.—The interior of the vagina is lined by a mucous membrane, the free surface of which presents, in the median line, two longitudinal folds or bands, one upon the anterior, and the other upon the posterior wall, called the *columns of the vagina.* Between these columns the membrane is thrown into numerous transverse folds, technically called *rugæ*, which are most abundant near the lower extremity, and gradually disappear in the direction of the uterus; they are very prominent in young virgins, but are partially effaced in women who have borne children. The surface of the membrane is covered by a squamous epithelium, and kept constantly moist by an almost inappreciable mucous secretion.

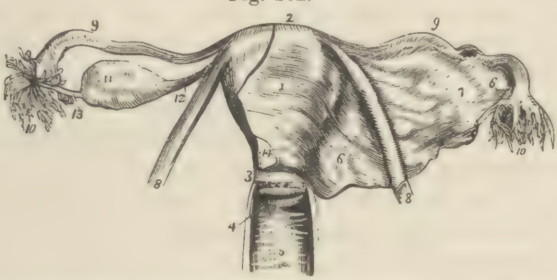
External to the mucous lining is a layer of very vascular spongy-looking tissue, composed of fibro-elastic and involuntary muscular fibres and small bloodvessels. It bears a close resemblance to the dartos layer of the scrotum.

Vessels and Nerves.—The *arteries* of the vagina are small but numerous; they are branches of the internal iliac, vesical, internal pudic, and uterine. The *veins* are abundant and large, and form an intricate network, called the *vaginal plexus*, around the lower part of the canal. The *lymphatics* enter the internal iliac and sacral glands. The *nerves* are principally derived from the hypogastric plexus of the sympathetic system, but many filaments, especially those which supply the entrance of the vagina, are branches of the fourth and fifth sacral and the pudic.

THE UTERUS.

The Uterus or Womb is situated in the cavity of the pelvis, between the bladder and rectum. It is shaped like a pear with its large end up, but flattened from before backward, and directed from above downward and backward, its axis corresponding with that of the superior strait of the pelvis. In adult virgins, it measures from $2\frac{1}{2}$ to 3 inches in length, $1\frac{1}{2}$ to 2 inches in breadth at its broadest part, and nearly 1 inch in thickness; it weighs from 1 to $1\frac{1}{2}$ oz. In young children it is very small, but is rapidly developed about the age of puberty, and becomes enormously enlarged during gestation. After parturition it speedily diminishes, but never regains entirely its virgin smallness or shape; so that, from this circumstance, independently of any other, it can be readily ascertained in a *post-mortem* examination whether the organ has ever been impregnated.

Fig. 162.



Anterior view of uterus and its appendages. 1, body of uterus; 2, its superior border or fundus; 3, its neck (cervix); 4, its mouth (os uteri); 5, vagina; 6, 6, broad ligament formed by peritoneum, which has been removed from opposite side; 7, prominence formed by subjacent ovary; 8, 8, round ligaments, cut where they enter internal inguinal ring; 9, 9, Fallopian tubes; 10, 10, their fimbriated extremities—on left side, extremity of tube is turned forward, to show its mouth or abdominal orifice; 11, ovary; 12, utero-ovarian ligament; 13, process of fimbriated extremity of tube connected to ovary; 14, cut edge of peritoneum on anterior surface of uterus, represented as descending rather lower than is really the case.

An examination of the *Exterior of the Uterus* will discover a little below its middle a slight constriction, which corresponds to a narrowing of its internal cavity, and divides the organ into a body and neck.

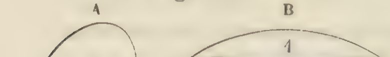
The *Body*, looked at either from before or behind, presents a triangular outline; it has therefore three borders, three angles, and two surfaces. The superior border or fundus rests upon a level with the superior strait of the pelvis; it is convex both antero-posteriorly and transversely, smooth, covered by peritoneum, and in contact with the small intestines. The lateral borders are nearly straight or slightly concave, incline toward each other from above, and give attachment to the broad ligaments. The superior angles, formed by the union of the superior and lateral borders, are rounded, and give attachment on each side

to the round ligament, Fallopian tube, and ligament of the ovary, in the order, from before backward, in which they are here mentioned. The inferior angle is continuous with the neck. The anterior surface is slightly convex, covered by peritoneum, and in relation with the bladder. The posterior surface is more convex than the anterior, also covered by peritoneum, and in relation with the rectum, one or more coils of intestine often intervening.

The *Neck* (cervix uteri) is from four to six lines long, and nearly cylindrical, but flattened slightly before and behind, and expanded a little above, where it is continuous with the body of the organ. Its anterior surface is not invested by peritoneum, but is closely connected with the base of the bladder by areolar tissue. The posterior surface is entirely covered by peritoneum, and is in relation with the rectum. The two lateral surfaces or borders give attachment to the lower part of the broad ligaments. The inferior extremity is rounded, projects into the vagina, is covered by mucous membrane, and presents a small transverse slitlike orifice, inclined to be circular in the virgin. It leads to the cavity of the uterus, and is hence called the *mouth of the uterus* (os uteri), *vaginal orifice*, or, from its resemblance to the mouth of a tench, *os tincæ*. The two thick borders of this orifice are called the anterior and posterior lips, of which the latter appears to be a little the longer, in consequence of the higher attachment of the vagina behind.

The *Interior of the Uterus* presents a small cavity lined by mucous membrane, and, in the body of the organ, is flattened from before backward, and triangular in shape. Its anterior and posterior walls are slightly convex and nearly in contact. Its two superior angles are each perforated by an exceedingly minute orifice leading to the oviduct or Fallopian tube, and its inferior is continuous with the cavity of the neck by a constricted circular opening called the cervico-uterine orifice (*os internum*).

Fig. 163.



A. Section of uterus antero-posteriorly. 1, back part of uterus; 2, vagina; 3, cavity of body; 4, cavity of neck.

B. Section of uterus from side to side. 1, fundus; 2, vagina; 3, cavity of body; 4, cavity of neck.

The cavity of the neck is also flattened from before backward, and wider at its middle than at either extremity. Upon its anterior and its posterior surface it is marked by a slight median ridge, from which numerous delicate wrinkles or rugæ of the lining membrane proceed upward and outward, producing a resemblance to a fern leaf, and called sometimes the *arbor vitæ* (Fig. 163).

The uterus is held in its place by the reflections of its peritoneal coat, by the round ligaments, and by the vagina. The reflections of the peritoneum form the two lateral or *broad ligaments* already mentioned; also two folds behind, called the *recto-uterine ligaments*, and two in front, called the *vesico-uterine*. The *round ligaments* are two rounded fibro-muscular cords, which originate, one on each side, from the superior angle of the uterus, being continuous with its tissue, pass outward and forward between the two layers of the lateral ligament, enter the internal inguinal ring, descend along the inguinal canal, and become blended with the areolar adipose tissue of the mons veneris.

Structure.—The uterus is lined internally by a mucous membrane, which in the body of the organ is of a light-red color, smooth, very thin, and closely attached to the subjacent tissue. Examined with a microscope, it is found to be covered with ciliated columnar epithelium, and upon its surface may be observed numerous minute orifices leading to little tubular glands, something like those found in the intestine, which are especially well seen in the impregnated organ. In the cavity of the neck, the mucous membrane is thicker, paler, disposed in the form of fine oblique ridges as above described, and provided with a squamous epithelium. Between the little ridges are numerous mucous follicles, which secrete a tenacious mucus that plugs up the outlet after impregnation. Sometimes one or more of these follicles present the appearance of little, transparent, vesicular bodies, called formerly the *ovula of Naboth*, produced by an obstruction in their ducts, and consequent accumulation of their secretion.

External to the mucous lining, and beneath the partial coat formed by the peritoneum, is the proper uterine tissue upon which the size and thickness of the organ depend. It is very dense and firm, cuts very much like cartilage, and consists of bundles of unstriped muscular fibres closely interwoven, and held together by an abundance of strong fibro-areolar tissue. In the virgin uterus, no particular arrangement of these fibres can be made out, but they are much elongated in the gravid state of the organ, when the following disposition is found to occur: 1, several superimposed circular laminæ surrounding the neck like a sphincter; 2, a superficial layer, originating upon each side of the body as far as the median line, the fibres converging to be inserted into the round ligaments; 3, a deep layer, situated just beneath the mucous membrane, consisting of broad concentric bands surrounding the orifice of each Fallopian tube, the outermost circles of fibres touching each other in the median line. Between these last two layers the muscular bundles have no regular arrangement, but cross each other in every direction.

Vessels and Nerves.—The *arteries* of the uterus are very small in the quiescent state of the organ, but become much enlarged during pregnancy, and ramify in a very tortuous manner. They are derived from two sources;

the principal are the two *uterine*, which arise, one on each side, from the internal iliacs, and reach the organ between the layers of the lateral ligaments. It receives branches also from the *spermatic* or *ovarian arteries*, which arise from the aorta, as in the male, and are distributed principally to the ovaries. The *veins* correspond to the arteries, but present a much more remarkable enlargement during pregnancy; they are very tortuous, destitute of valves, and composed of only the internal venous coat. The *lymphatics* are very numerous, and terminate in the glands situated along the internal iliac vessels and the lumbar vertebræ; a few also pass along the round ligaments to the inguinal glands. The *nerves* can, with the greatest difficulty, be followed into the substance of the virgin uterus, but in the gravid organ they may be readily traced throughout every part of the muscular tissue, in which they form numerous large plexuses. They are derived principally from the hypogastric plexus, a few coming from the renal, and accompany the spermatic and uterine arteries. Those from the hypogastric plexus contain a few white fibres from the cerebrospinal system, which are distributed principally to the neck of the organ.

THE FALLOPIAN TUBES.

The Fallopian Tubes or Oviducts (Fig. 162) are two membranous canals for conveying the ova from the ovaries to the uterus. They are from three to four inches in length, continuous with the superior angles of the uterus, and inclosed, on each side, by the middle fold of the broad ligament. Traced from their connection with the uterus, they are at first small, cylindrical, and cordlike, but gradually increase to the size of a large goosequill at their outer extremities, which are free and floating and marked by numerous fringelike processes, technically called *fimbriæ*. The direction of each tube is at first transverse, but within a short distance of its outer extremity it is curved, with the concavity presenting backward and downward. The outer or fimbriated extremity looks, therefore, toward the corresponding ovary, to the outer extremity of which it is attached by one of the fimbriæ. The canal of the tube corresponds somewhat in shape to that of its exterior; it is exceedingly small where it communicates with the uterus, barely admitting a fine bristle, but gradually expands toward its fimbriated extremity, whose patulous orifice communicates ordinarily with the sac of the peritoneum, but, during the monthly excitement, is supposed to be applied to the surface of the ovary.

Structure.—The walls of the oviducts are thick and firm near the uterus, but become thinner toward the fimbriated extremity, and consist, like the uterus, of three structures, namely, a serous, a muscular, and a mucous tunic. The *serous coat* is derived from the peritoneum, and invests the whole of the exterior of the tube, except a narrow space along

its lower border. The *muscular coat* consists of unstriated fibres closely interwoven with an abundance of fibro-areolar tissue, and is in all respects similar to the proper tissue of the uterus. The *mucous lining* is a prolongation of that of the uterus, and is continuous at the fimbriated extremity of the tube with the serous lining of the abdomen, this being the only instance of the kind in the body. The epithelium covering the mucous membrane is ciliated and columnar.

THE OVARIES.

The Ovaries (Fig. 162), the homologues of the testicles in the male, are two oval-shaped bodies about the shape and size of an almond, of a whitish or pale pink color, and a somewhat uneven surface. They are situated upon each side, in the posterior fold of the broad ligament of the uterus, and connected to the corresponding superior angle of this organ by a small fibrous band called the *ligament of the ovary*, and by the opposite extremity to one of the fimbriæ of the Fallopian tube. In the fœtus, they are placed in the cavity of the abdomen just below the kidneys; but afterward descend to the superior back part of the pelvic cavity, and are again, by the enlargement of the uterus, carried upward during pregnancy into the cavity of the abdomen, where they occasionally become confined by adhesion. After parturition, however, they are generally found in the iliac fossæ. They vary considerably in size in different individuals, but are generally larger in adult virgins than in matrons, and measure about an inch and a half in length, three-fourths of an inch in depth, and half an inch in thickness. Like the testicles, they are small in early life, and undergo rapid development at the age of puberty.

Structure.—The ovary has a partial investment of serous membrane derived from the peritoneum, and beneath this a complete envelope of strong fibrous membrane closely connected to the inclosed tissue. The latter, the *proper tissue* of the organ, is a firm, dense, pinkish-white, granular structure, called the *stroma*, in which are found from twelve to twenty or more vesicular bodies or cysts, varying in size from a pin's head to a small pea, and containing a clear albuminous fluid. These cysts, called the *Graafian vesicles* or ovisacs, are composed of a fibro-vascular tunic, a basement membrane, and a lining of polyhedral epithelial cells. Floating in the inclosed fluid is the true *ovum*, a small spherical body about $\frac{1}{120}$ of an inch in diameter, composed of a transparent envelope (vitelline membrane) and an inclosed granular fluid called the *yolk*. In the yolk is a still smaller *germinal vesicle* or nucleus, measuring about $\frac{1}{720}$ of an inch in diameter, in which is an opaque spot $\frac{1}{3000}$ of an inch in diameter, named the *germinal spot* or nucleolus.

The ovisacs found near the centre of the ovary are exceedingly small; but gradually approaching the circumference they increase in size, and

subsequently form a prominence upon the exterior of the organ. While this is going on the ovum also enlarges, and finally ruptures the inclosing membranes, and is received by the oviduct, the fimbriated extremity of which grasps the ovary in such a manner that its open mouth is applied over the point upon the ovary at which the rupture takes place. After the escape of the ovum, the little lacerated spot cicatrizes, and the Graafian vesicle becomes contracted and yellow, forming what is technically called a *corpus luteum*. In the course of time this corpus luteum becomes absorbed, and not the least vestige of it can be discovered, but the little cicatrix on the surface of the ovary may be detected for a long time afterward.

The time required for the complete maturation of the ovum is not positively ascertained, but it is now generally believed that one escapes at each monthly period from one or the other ovary, or from both.

Vessels and Nerves.—The *ovarian arteries and veins*, one upon each side, correspond to the spermatic arteries and veins in the male, and their course along the posterior wall of the abdomen behind the peritoneum is the same. The *lymphatics* open into the lumbar and sacral glands. The *nerves* are branches of the hypogastric plexus.

VESSELS AND NERVES OF THE PELVIC CAVITY.*

Dissection.—The arteries and veins of the cavity of the pelvis are branches of the internal iliac, and may be easily dissected by commencing with the trunks of these vessels and following out their subdivisions. The nerves belong to the cerebro-spinal and sympathetic systems, and require much more care in their exposure; those from the spinal cord emerge at the anterior sacral foramina and form a large plexus (sacral plexus) on each side in the lower back part of the pelvis, and can be readily brought into view by turning the rectum out of the cavity; the sympathetic nerves lie alongside of the sacral foramina, and may be distinguished by their pearly white color and the enlargements or ganglia that occur at different points. Branches from the abdominal ganglia, sacral plexus, and particularly from the sacral ganglia of the sympathetic, unite to form a large plexus (hypogastric plexus) in front of the promontory of the sacrum, and will demand for complete exposure (which the beginner is not advised to attempt) a careful removal of the rectum and the surrounding areolar and adipose tissue.

The **Internal Iliac Artery** commences at the bifurcation of the common iliac, upon the brim of the pelvis in front of the sacro-iliac symphysis, descends almost vertically in front of the sacro-iliac junction to the superior margin of the sacro-ischiatic foramen, a distance of about an inch and a half, and divides into an anterior and a posterior branch. In its course it crosses the inner border of the psoas muscle, rests upon the internal iliac vein, lumbo-sacral nerve, and upper part of the pyriform muscle, is covered in front by the peritoneum, and crossed by the corresponding ureter.

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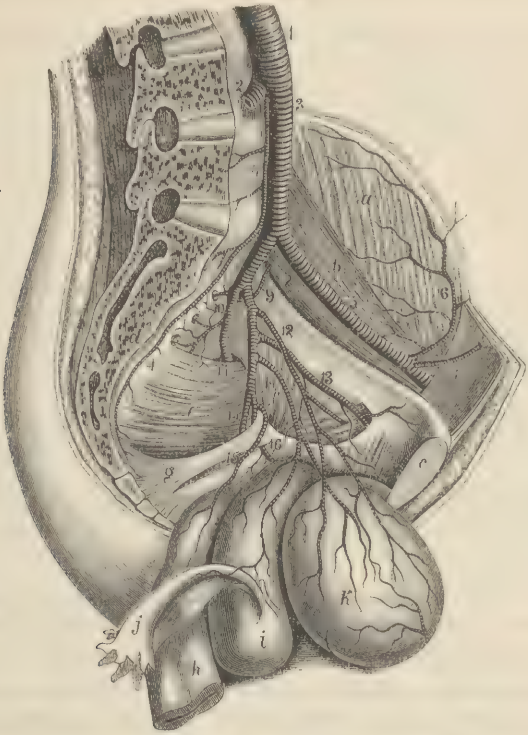
* The Vessels and Nerves both of the Male and Female Pelvis are described here conjointly, a full knowledge of the contents of the cavity and of the organs of generation being requisite, in order to compare the vascular and nervous distribution in each sex.

The Anterior Division gives off the superior and inferior vesical, middle hemorrhoidal, obturator, internal pudic, and ischiatic or sciatic arteries; the origin of the vessels in both divisions is subject to great variation, but there is no difference in the two sexes.

Fig. 164.



View of left side of pelvis, bladder, uterus, vagina, and rectum, turned downward so as to exhibit distribution of internal iliac artery. 1, aorta; 2, right common iliac artery; 3, left common iliac; 4, middle sacral; 5, external iliac; 6, circumflex iliac; 7, epigastric; 8, internal iliac; 9, ilio-lumbar; 10, lateral sacral arteries; 11, gluteal artery passing from pelvis, above pyriform muscle, at upper part of great sacro-sciatic foramen; 12, superior vesical artery; the branch cut off is extended into remains of umbilical artery; 13, obturator artery; 14, inferior vesical artery giving off uterine artery to vagina and uterus; 15, middle hemorrhoidal artery; 16, internal pudic artery, seen emerging from and again entering pelvis; 17, ischiatic artery. *a*, iliac muscle; *b*, psoas muscle; *c*, symphysis of pubis; *d*, sacrum; *e*, pyriform muscle; *f*, internal obturator muscle; *g*, sacro-sciatic ligaments; *h*, rectum; *i*, uterus and vagina; *j*, Fallopian tube; *k*, bladder.

The **Superior Vesical Artery** is the first portion of the umbilical of the fœtus, which remains pervious as far as its branches to the bladder, but beyond this point is converted into a fibrous cord contained in a fold of the peritoneum. It is small, ascends forward from its origin, and gives branches to the side of the bladder.

The **Inferior Vesical Artery** not unfrequently originates from one of the other branches of the internal iliac, but generally from the anterior divi-

sion immediately below the preceding. It is very small and short, passes inward, and is distributed to the base of the bladder and prostate gland.

The **Middle Hemorrhoidal Artery** frequently comes off by a common trunk with the preceding, and in other cases some distance below; it passes horizontally inward, and is distributed upon the lower part of the rectum.

The **Obturator Artery,** about the size of a crowquill, and generally a branch of the anterior division of the internal iliac, sometimes comes from the posterior, and sometimes from the external iliac, beneath the crural arch. From its usual point of origin it is directed forward along the lateral wall of the pelvis, passes through the opening in the obturator membrane in company with the obturator nerve, and is distributed to the muscles upon the inner side of the thigh. When it is a branch of the external iliac or femoral, it usually arises by a common trunk with the epigastric, passes inward along the posterior border of the inner extremity of the crural arch, as far as the spine of the pubis, thus almost encircling the internal femoral ring, and then descends vertically behind the body of the pubis to reach the opening in the obturator membrane. In other cases it comes off singly, and descends immediately along the outer border of the femoral ring to the above-mentioned opening.

The **Internal Pudic Artery,** larger than the preceding, descends immediately from its origin, across the front of the pyriform muscle and sacral nerves, to reach the great sacro-ischiatic foramen, through the lower part of which it leaves the cavity of the pelvis in company with the sciatic artery; it immediately re-enters, however, through the small sacro-ischiatic foramen, gains the inner surface of the tuberosity of the ischium, ascends forward and toward its fellow of the opposite side along the inner surface of the ramus of the ischium and pubis, perforates the deep perineal fascia beneath the arch of the pubis, and divides into its two ultimate branches, the dorsal artery of the penis and the artery of the cavernous body. While situated upon the inner surface of the tuberosity of the ischium, it is at least an inch from the lower border of this bone, but, as it ascends the ramus, it gradually approaches its anterior border and crosses it beneath the pubic arch.

It is accompanied by a corresponding vein and nerve, and, in the male, gives off in its course the following principal branches: 1, the *inferior* or *external hemorrhoidal* to the lower part of the rectum; 2, the *superficial perineal* to the superficial parts of the perineum and back of the scrotum; 3, the *artery of the bulb*, given off from the main trunk while lying behind the perineal fascia, and distributed to the bulb of the penis as already described; 4, the *artery of the cavernous body* of the penis, which enters the root of this organ and ramifies throughout its entire extent; 5, the *dorsal artery of the penis*, which runs along the corresponding side of the groove between the two cavernous bodies upon the

upper surface of the penis, and is distributed principally to the head of this organ, sending branches also to the cavernous bodies.

Sometimes the internal pudic is very small, and terminates in the artery of the bulb or in the superficial perineal. In this case, the deficiency is made up by the existence of an anomalous vessel, called the *accessory pudic.* This accessory vessel, when present, generally originates by a common trunk with the internal pudic, descends alongside of the base of the bladder, passes over the superior surface of the prostate, then along by the membranous portion of the urethra, and, perforating the deep perineal fascia, terminates in the dorsal artery of the penis and cavernous artery. Its relations to the prostate gland and membranous portion of the urethra are of the utmost importance in a surgical point of view; but, happily for the lithotomist, its existence is by no means common.

The internal pudic is much smaller in the female than in the male, but follows the same course and gives off: 1, a *superficial perineal branch* to the labia; 2, a *bulbous branch* to the erectile tissue behind the labia; and two small *branches to the clitoris*, one of them corresponding to the dorsal artery of the penis in the male.

The **Ischiatic** or **Sciatic Artery,** a little larger than the pudic, descends in front of the pyriform muscle, leaves the cavity of the pelvis at the lower part of the great sacro-ischiatic foramen in company with the sciatic nerve, continues its descent midway between the tuberosity of the ischium and the great trochanter, and is distributed to the muscles on the upper back part of the thigh, sending also a twig to the sciatic nerve and one or two to the hip joint.

The **Uterine Artery,** also a branch of the anterior division of the internal iliac in the female, passes downward between the layers of the lateral ligament, then ascends in a tortuous manner along the border of the uterus, and gives off numerous branches which enter the substance of the organ. This vessel becomes very much enlarged during pregnancy.

The **Vaginal Artery** corresponds to the inferior vesical in the male, ascends in the lateral wall of the vagina, and sends branches also to the base of the bladder.

The Posterior Division gives off the ilio-lumbar, lateral, sacral, and gluteal Arteries.

The **Gluteal Artery** is the largest of the branches of the internal iliac, but its course within the cavity of the pelvis is very short, for it almost immediately turns around the upper margin of the great sacro-ischiatic foramen, to be distributed to the muscles upon the outer surface of the ilium. Having left the pelvic cavity, it immediately divides into two branches—a *superficial*, which ramifies between the large and middle gluteal muscles, perforates the former, and anastomoses on the back of

the sacrum with the sacral arteries; and a *deep* branch, which follows the superior curved line on the dorsal surface of the ilium, between the middle and small gluteal muscles, and is distributed to all the adjacent parts as far as the anterior border of the bone.

The **Ilio-lumbar Artery**, much smaller than the gluteal, ascends beneath the psoas muscle and external iliac artery and vein, lying in close contact with the sacro-iliac junction, to the margin of the iliac fossa, where it divides into a *lumbar* and an *iliac* branch. The former is distributed to the psoas and square muscles, and sends branches through the intervertebral foramina to the parts within the spinal canal; the latter enters the substance of the iliac muscle, and anastomoses with the circumflex artery of the ilium (a branch of the external iliac beneath the crural arch), near the anterior superior spinous process of this bone.

The **Lateral Sacral Arteries**, usually two in number, descend a little inward in front of the pyriform muscle, and divide into several branches, which enter the anterior sacral foramina to be distributed to the back of the nerves situated in the sacral portion of the spinal canal. Some of the branches continue on through the posterior sacral foramina, and are spent upon the cutaneous and muscular tissues in this situation.

The **Internal Iliac Vein** is formed by the union of veins that accompany the several branches of the internal iliac artery. It ascends in front of the corresponding sacro-iliac symphysis, behind the internal iliac artery, and unites with the external iliac vein to form the common iliac. It returns the blood from the pelvic organs, the external organs of generation in the female, the penis in the male, and the muscles on the back of the ilium.

The **Anterior Sacral Nerves** are six in number on each side, and very large. The first four emerge at the anterior sacral foramina, are joined by the lumbo-sacral (a branch of the lumbar plexus), and converge toward the great sacro-ischiatic foramen to form the sacral plexus. The last two (the fifth and sixth) are very small, descend through the lower extremity of the sacral canal, and are distributed to the coccygeal muscle and neighboring integument.

The **Sacral Plexus**, formed, as above mentioned, by the interlacement of the lumbo-sacral and first four anterior sacral nerves, is flattened from before backward. It is triangular, rests upon the anterior surface of the pyriform muscle, and is covered in front by the pelvic fascia and internal iliac vessels.

Its *collateral branches* are: 1, three or four small filaments to the back of the rectum, base of the bladder, and hypogastric plexus in front of the sacral promontory; 2, a small branch to the elevator of the anus; 3, a filament to the internal obturator muscle; 4, the *internal pudic* nerve which accompanies the artery of the same name; 5, a small branch

to the square and twin muscles on the back of the thigh; and 6, the *small sciatic* nerve, which, as will be hereafter seen, passes through the great sacro-ischiatic foramen to be distributed to the great gluteal muscle, and the integument of the back of the thigh. The *terminal branch* is the *great sciatic* nerve, the largest nerve in the body, which arises from the inferior extremity of the plexus, and descends through the great sacro-ischiatic foramen, below or in front of the pyriform muscle, in company with the sciatic artery. Its course along the back of the thigh will be hereafter seen.

The **Sympathetic Nerves** in the pelvis are continuations of the two lumbar sympathetic nerves, but very small. They lie upon the anterior surface of the sacrum along the inner side of the sacral foramina, opposite each of which they present a small oval enlargement or ganglion. From these ganglia branches are given to the hypogastric and sacral plexuses. and from the last of the series a filament crosses to its fellow of the opposite side, and presents, at its middle, a small enlargement called the *azygos ganglion* (ganglion impar).

The **Hypogastric Plexus** is situated in the areolar tissue behind the rectum, and in front of the upper part of the sacrum. It is made up of numerous small filaments from both the sympathetic and cerebro-spinal systems. The branches from the sympathetic system are derived principally from the aortic plexus situated upon the front of the aorta, between the superior and inferior mesenteric arteries; from the lumbar and sacral ganglia and inferior mesenteric plexus. They vary in number from ten to fifteen on each side, are very small, and descend alongside of the aorta and over the common iliac arteries. The white or cerebro-spinal filaments are offsets from the sacral plexus. After uniting in a very intricate manner, the fibres of the plexus divide into two sets, which proceed forward by the side of the rectum, forming what are called the *inferior hypogastric plexuses.* From these lateral prolongations, filaments are distributed to all of the contained viscera, the white or cerebro-spinal fibres being sent for the most part to the neck of the bladder, vagina, neck of the uterus, and lower extremity of the rectum.

The **Coccygeal Muscle**, also seen in this dissection, situated in front of the sacro-ischiatic ligaments, is thin, flat, and triangular; it arises broad from the border of the coccyx and adjacent part of the sacrum, and is inserted by a narrow-pointed extremity into the inner surface of the spine of the ischium. It is in relation, anteriorly and laterally, with the dilated portion of the rectum, posteriorly and inferiorly with the sacro-ischiatic ligaments and great gluteal muscle. Its use is to raise the coccyx forward, and thus assist in defecation; the action of only one muscle would draw the coccyx toward the corresponding side.

THE INFERIOR EXTREMITIES.

HAVING completed the dissection of the interior of the pelvis, the student may proceed to that of the lower limbs, devoting the left one, which (if the preceding directions have been followed) remains attached to the trunk, to the special study of the muscles, and reserving the right, which has been already laid aside, for the dissection of the bloodvessels and nerves.

MUSCLES OF THE INFERIOR EXTREMITY.

Before commencing the dissection of the muscles of the lower extremities, it is well to consider previously, in a general way, the movements of which they are capable. Obviously, their most important function is progression. For this, several combined and opposite movements are necessary: thus, in raising the foot from the ground, the thigh is bent forward, the leg backward, the foot upward, and the toes downward; or, in other words, the thigh is *flexed* upon the pelvis, the leg upon the thigh, the foot upon the leg, and the toes upon the foot. But when the foot is pressed upon the ground to carry the body forward, the movements are reversed; the toes are *extended* upon the foot, the foot upon the leg, the leg upon the thigh, and the thigh upon the pelvis. It will be readily understood, then, why muscles which perform these movements are placed alternately upon the anterior and posterior aspects of the limb, and upon the part or section above the one to be acted upon. Thus, the flexors of the thigh are placed upon the front of the pelvis, the extensors of the leg upon the front of the thigh, the flexors of the foot and extensors of the toes upon the front of the leg and foot, the extensors of the thigh upon the back of the pelvis, the flexors of the leg upon the back of the thigh, and the extensors of the foot and flexors of the toes upon the back of the leg and bottom of the foot.

But in addition to the straightforward and backward movements, the several large joints of the lower extremities are capable of more or less lateral movement, as abduction, adduction, and rotation. These are most extensive at the hip joint, slight at the ankle, and almost entirely wanting at the knee.

To perform all these several movements, each limb is provided with fifty-seven muscles, of which twelve are situated upon the pelvis, anteriorly and posteriorly, thirteen upon the thigh, twelve upon the leg, and twenty upon the foot. The excellent practical arrangement of these muscles perfected by Prof. Robert Harrison, M.D., of the University of Dublin, is inserted here, although it is not supposed that the student will fully appreciate it, until, by dissection, he has become familiar with the individual muscles themselves.

In the first place, each limb is divided into four *regions*—the pelvic, the femoral or region of the thigh, the crural or region of the leg, and the pedal or region of the foot,—which are subdivided into anterior pelvic, posterior pelvic, anterior femoral, posterior femoral, internal femoral, etc. Secondly, some of these regions contain muscles acting upon different parts, which gives rise to a division into *classes:* for instance, upon the thigh, there are muscles that move the thigh, and others that move the leg; upon the leg, muscles that move the foot, and others that move the toes, etc. Thirdly, these classes comprise muscles whose special function is different, some being flexors, some extensors, etc., which justifies a farther division into *groups.* Lastly, some of the groups consist of one or more *layers.*

With this explanation, the student will understand the following table:

MUSCLES OF THE INFERIOR EXTREMITY.

I. PELVIC REGION—(Anterior and Posterior).

One Class—(*Movers of the Thigh*)—Three Groups.

First Group—*Flexors* . . .	1. Small psoas muscle. 2. Large psoas muscle. 3. Iliac muscle.
Second Group—*Extensors* . .	1. Large gluteal muscle. 2. Middle gluteal muscle. 3. Small gluteal muscle.
Third Group—*Rotators* . .	1. Pyriform muscle. 2. Internal obturator muscle. 3. External obturator muscle. 4. Superior twin muscle. 5. Inferior twin muscle. 6. Femoral quadrate or square muscle.

II. FEMORAL REGION—(Anterior, Internal, and Posterior).

First Class—(*Movers of the Thigh*)—One Group.

One Group—*Adductors* . . .	1. Pectineal muscle. 2. Large adductor muscle. 3. Long adductor muscle. 4. Short adductor muscle.

SECOND CLASS—(*Movers of the Leg*)—THREE GROUPS.

First Group	1. Tensor of the femoral fascia. 2. Sartorial muscle. 3. Gracilis muscle.
Second Group—*Extensors* . .	1. Straight femoral muscle. 2. Triceps muscle.
Third Group—*Flexors* . . .	1. Semitendinous muscle. 2. Semimembranous muscle. 3. Biceps muscle. 4. Popliteal muscle.

III. CRURAL REGION—(ANTERIOR, EXTERNAL, AND POSTERIOR)—
THREE GROUPS.

First or Anterior Tibial Group		1. Anterior tibial muscle—flexor of the foot. 2. Long extensor of the great toe. 3. Common long extensor of the toes.	
Second or Peroneal Group		1. Long peroneal muscle 2. Short peroneal muscle	Extensors of the foot.
		3. Third peroneal muscle—flexor of the foot.	
Third or Posterior Tibial Group	*Superficial Layer*	1. Gastrocnemius 2. Soleus 3. Plantaris	Extensors of the foot.
	Deep Layer	1. Posterior tibial—extensor of the foot. 2. Common long flexor of the toes. 3. Flexor of the great toe.	

IV. PEDAL REGION—(DORSAL AND PLANTAR).

FIRST CLASS—(*Movers of the Toes in General*)—THREE GROUPS.

First Group	1. Short extensor of the toes.
Second Group	1. Short flexor of the toes. 2. Accessory flexor of the toes.
Third Group	1. Four lumbricales. 2. Transverse muscle. 3. Eight interosseous muscles—adductors and abductors of the toes.

SECOND CLASS—(*Movers of Individual Toes*)—TWO GROUPS.

First Group	1. Short flexor of the great toe. 2. Short flexor of the small toe.
Second Group . . .	1. Abductor of the great toe. 2. Abductor of the small toe.

The muscles of the inferior extremities cannot be described strictly in the order in which the regions are arranged in the table, but will be considered as they become most conveniently revealed by dissection.

The three muscles, namely, the small psoas, large psoas, and iliac, situated upon the anterior pelvic region, are all flexors of the thigh at the hip joint, and have been already studied in connection with the posterior wall of the abdomen. Those upon the posterior pelvic region can be more profitably dissected, after those of the anterior and internal femoral regions are disposed of.

ANTERIOR FEMORAL REGION.

The Muscles of the Thigh are invested by the skin, superficial fascia or subcutaneous areolar tissue, and a strong fibrous membrane called the *femoral aponeurosis* or *fascia lata.* In the subcutaneous areolar tissue are a number of veins, branches of the internal or long saphenous vein which passes from the leg along the inner side of the thigh, toward the groin, resting upon the external surface of the aponeurosis.

Dissection.—The skin and superficial fascia may be removed together, so as to expose the surface of the femoral aponeurosis and the internal saphenous vein. For this purpose, place a block under the upper back part of the thigh, and make an incision from the middle of the crural arch, passing along the middle of the anterior surface of the thigh over the anterior surface of the patella, to about an inch below the anterior tuberosity of the tibia. Next, intersect the lower extremity of this long incision by a transverse one, extending across the upper part of the leg. Dissect back the skin from the middle line, carrying the outer flap as far around as can be conveniently done, and the internal one as far as the prominent ridge formed along the inner side of the thigh by the gracilis muscle.

In performing this dissection, a number of lymphatic glands will be noticed in the region of the groin; and here, also, the subcutaneous areolar tissue will be seen to be very abundant, divisible into several layers, and traversed by numerous small veins and arteries. The deep portion of this areolar tissue is here styled the *cribriform fascia*, and forms one of the coverings of a hernia in this situation. Immediately below this point the superficial fascia is closely adherent to the femoral aponeurosis, a fact whose practical bearing will be pointed out in connection with femoral hernia.

The nervous filaments, divided in turning back the skin and fascia, are cutaneous branches of the lumbar and crural nerves.

The **Femoral Aponeurosis** (*fascia lata*) is a fibrous membrane, and forms a common envelope or sheath for the muscles of the thigh, for the purpose of confining them firmly in their places during their contraction. It is exceedingly dense and strong along the outer aspect of the limb, and beneath the crurel arch and anterior spines of the ilium; but weak, thin, and blended with the superficial fascia, along the inner surface of the thigh, and upon the nates. It is attached, *above*, to the sacrum, coccyx, crest of the ilium, anterior margins of the large and middle gluteal muscles, crural arch, body and spine of the pubis, and ramus and tuberosity of the ischium; *externally*, to the whole length of the rough line (linea aspera) of the femur, forming in this situation a strong septum between the muscles upon the outer and those upon the back part of the thigh; *internally*, it is also prolonged down to the same rough line of the femur, forming a thinner septum between the extensor and adductor muscles; *below*, it is connected to the condyles of the femur, tuberosities of the tibia, and head of the fibula, covers the patella, and is continuous with the tendons of several of the muscles that surround the knee. It moreover sends numerous thin processes or layers from its deep surface to form separate sheaths for the individual muscles underneath.

The femoral aponeurosis is perforated at different points for the passage of vessels and nerves, but the openings are generally small and unimportant, except the one occupied by the internal saphenous vein. This is situated in the bottom of a considerable depression found just beneath the inner extremity of the crural arch; it is vertically oval in form, and bounded externally and above by a prominent crescentic border, continuous with the internal extremity of the crural arch. The important practical relation of these structures to femoral hernia will be hereafter described.

The femoral aponeurosis is composed of bundles of closely interwoven white fibres, which for the most part run horizontally around the limb. At its thickest part, longitudinal fibres are equally numerous, and at one point form a thickened band one or two inches broad, which extends from the anterior superior spinous process of the ilium and the adjacent part of the crest, almost vertically downward, and is inserted into the outer side of the head of the tibia. Just beneath the superior spine of the ilium, the aponeurosis is separable into two layers, which inclose the tensor muscle.

Dissection.—First expose the tensor muscle by dividing the outer layer of the fascia longitudinally for a few inches below the anterior superior process of the ilium and turning it back. Having examined the muscle, make a vertical incision through the aponeurosis extending from the pubis to the inner side of the knee and turn it outward, cutting it, as the dissection progresses, from its various attachments above and below, and dividing the intermuscular septa which are connected with its under surface.

The **Tensor Muscle of the Femoral Fascia** (*tensor vaginæ femoris*) (Fig. 165, $_1$), short, flat, and quadrilateral, is situated between the two layers of the femoral aponeurosis, in the upper outer part of the thigh. It originates tendinous from the outer surface of the anterior superior spine of the ilium, between the middle gluteal and sartorial muscles, passes downward and a little backward to the distance of three or four inches, and is inserted into the thick bandlike portion of the femoral aponeurosis.

Use.—To make the aponeurosis tense, and rotate the thigh slightly inward. The latter action is effected by means of the thick bandlike portion of the aponeurosis, which is inserted into the outer condyle of the femur and corresponding tuberosity of the tibia.

Relations.—Inclosed by the two layers of the femoral aponeurosis, it is at first placed between the middle gluteal and sartorial muscles, and in its course lies nearly parallel with and upon the anterior margin of the former, diverging from the latter to form an angular interval, in which a part of the rectus muscle may be seen.

The **Sartorial Muscle**[6] (*sartorius*), the longest in the body, is narrow, flattened, and somewhat larger a little below its middle than at either ex-

tremity. It arises, by short tendinous fibres, from the anterior superior iliac spine and upper half of the subjacent notch, descends inward, crossing the superior and middle thirds of the thigh obliquely, to reach the back part of the internal condyle of the femur, where, becoming tendinous, it continues on in a vertical direction, and, having passed the knee joint, turns forward, and spreads out to be inserted into the crest of the tibia just below the anterior tuberosity.

Use.—To flex the leg upon the thigh, turning it at the same time inward across the opposite, and, when this is accomplished, to flex and adduct the thigh upon the pelvis; if the leg is fixed as in standing, it may assist in flexing the trunk upon the thighs, and rotate it in an opposite direction.

Fig. 165.

Muscles of anterior femoral region. 1, tensor of femoral aponeurosis; 2, pectineus; 3, rectus or straight femoral; 4, external head (vastus externus), 5, internal head (vastus internus), of triceps extensor: 6, sartorial muscle; 7, long adductor.

Relations.—The sartorial belongs to the superficial group, and is covered, therefore, by only the femoral aponeurosis and skin. It crosses in its course the femoral portion of the internal iliac and psoas, the triceps, internal head of the biceps, long adductor, gracilis, and great adductor muscles, and at its insertion lies in front of the tendons of the semitendinous and gracilis muscles, a bursa intervening. Its most important relation, however, is with the femoral vessels; thus, in the superior third of the thigh, it forms, with the crural arch and long adductor muscle, a triangular space, through the middle of which the femoral artery takes a nearly vertical course, accompanied by the femoral vein and crural nerves; in the middle third, the muscle lies obliquely across the vessels, which may be, therefore, found along its superior or inferior borders; in the lower third, the artery is situated upon the back of the limb, and has no immediate relation with the muscle.

The **Gracilis Muscle**, long and slender, flattened laterally, and gradually tapering from above downward, forms the inner border of the anterior region of the thigh. It arises, by a short but broad tendon, from the anterior surface of the internal extremity of the pubic bone, close to the lower part of the symphysis, and from the descending ramus of the same, and descends almost

vertically to the back part of the internal condyle of the femur, where it ends in a rounded tendon, which turns around the knee to be inserted into the crest or spine of the tibia, behind the attachment of the sartorial.

Use.—To flex the leg, turning it at the same time inward; and secondarily, to adduct the thigh. Acting from the leg as a fixed point, it assists in flexing the trunk upon the thighs.

Relations.—The gracilis belongs to the superficial femoral group, and is covered, therefore, by only the femoral aponeurosis and skin. Its internal or deep surface is in contact, in the upper part of the thigh, with the adductor group of muscles, and below with the knee joint and internal lateral ligament of the same, a bursa, common to it and the semitendinous, intervening. At its insertion, it is covered by the expanded tendon of the sartorial, with which, and that of the semitendinous, it is connected by an aponeurotic expansion.

Dissection.—Detach the tensor of the femoral fascia from its connections, and turn the sartorial inward, and the crural extensor group, consisting of the rectus and triceps, already in a great measure exposed, will be brought fully into view.

The **Rectus or Straight Muscle**[3] (*rectus femoris*) is one of the large muscles of the thigh, and extends, in the middle line of the limb in front, from the pelvis to the upper part of the leg. It is somewhat fusiform in shape, being larger at the middle than at either extremity, flattened from before backward, and bipenniform, its fibres running obliquely toward a central aponeurotic septum. It arises by two short, rounded tendons, one from the anterior inferior iliac spine, and the other from the internal border of the acetabulum and capsular ligament, descends almost vertically, inclining a little inward, and is inserted by a broad flattened tendon into the upper border of the patella, in common with the triceps, and by the ligament of the patella into the lower part of the anterior tuberosity of the tibia.

Use.—To extend the leg, and, secondarily, to assist in flexing the thigh, or, if the leg is the fixed point, to assist in flexing the trunk upon the lower extremities.

Relations.—The superior extremity of the muscle is crossed obliquely from above, downward and inward, by the sartorial, overlapped internally by the outer border of the femoral portion of the iliac muscle, and externally by the tensor of the femoral fascia and middle and small gluteal muscles; it rests, above, upon the capsular ligament of the hip joint, and, below this point, lies upon the middle portion of the triceps; it is covered throughout the lower three-fourths of its extent only by the femoral aponeurosis and skin.

Dissection.—Divide the rectus within three or four inches of its origin, and turn it downward.

The **Triceps Extensor Muscle** is the largest muscle in the femoral region, and consists, as its name indicates, of three heads or divisions, of which the external is commonly called the *vastus externus*, the internal the *vastus internus*, and the middle the *crureus*.

The *Vastus Externus*[4] (the external head), the largest of the three, arises tendinous from the root of the great trochanter, from the external edge of the rough line of the femnr, and from the bifurcation of this line which leads to the external condyle, and fleshy from the process of the femoral aponeurosis that separates it from the muscles upon the posterior aspect of the thigh, and from the surface of the bone upon which it lies. Its external surface is tendinous above and fleshy below; its internal is fleshy above and tendinous below. Its fibres pass downward and inward, with different degrees of obliquity, the most inferior being nearly horizontal; in their course they become partly blended with those of the middle and internal head, and partly with the tendon of the rectus, and are inserted into the outer half of the upper border of the patella. It may be separated from the middle head or crureus almost to the patella, and is covered throughout by the femoral aponeurosis, but overlapped above by the great gluteal muscle, and crossed by the tensor of the fascia.

The *Vastus Internus*[5] (the internal head) occupies the inner aspect of the thigh. It is broad below and pointed above, arises tendinous from the intertrochanteric line, and from the whole length of the inner edge of the rough line (linea aspera), and fleshy from the surface of the bone upon which it lies and the aponeurotic prolongation of the femoral fascia that separates it from the adductor muscles; its fibres descend obliquely forward, and are inserted into the tendon of the rectus, the side of the patella, and, by an aponeurotic expansion covering the inner side of the knee joint, into the head of the tibia. It is covered above by the sartorial and throughout the remainder of its extent by the femoral aponeurosis.

The *Crureus* (the middle head) is situated between the internal and external, and so intimately blended with the former that the two cannot be separated. It arises from the anterior surface of the femur from the intertrochanteric line above, to within three or four inches of the knee, passes downward and a little forward, and is inserted tendinous into the upper border of the patella, behind the insertion of the rectus. It lies beneath the rectus, and is separated from the bone above the knee joint by a prolongation of the synovial membrane of the joint.

Action.—The true insertion of the triceps being the base of the anterior tuberosity of the tibia, through the ligament of the patella common also to the rectus, its special action is extension of the leg. It is probably the most powerful muscle in the body, and its sudden contraction has been known to fracture the patella, and to tear away the anterior tuberosity of the tibia.

Relations.—The internal and external divisions of the triceps (internal and external vastus) are for the most part covered only by the femoral aponeurosis and skin; but the superior extremity of the former is crossed by the sartorial, and the corresponding part of the latter by the tensor of the fascia, and overlapped by the lower margin of the great gluteal muscle. The middle division (crureus) is covered throughout its whole extent entirely by the rectus. The inner head is separated from the adductor group by a process of the femoral aponeurosis, and, in the middle third of the thigh, is in relation with the femoral artery, which lies here inclosed in a fibrous sheath, given off from this muscle and the long adductor. Its outer border is separated from the muscles upon the posterior femoral region by a strong process of the femoral fascia.

The name *Subcrureus* or *Capsular Muscle* is sometimes applied to a few fleshy fibres situated beneath the middle division or crureus, of which they are a part. They are inserted into the highest point of the synovial membrane of the knee joint, and their use is to keep the synovial membrane from folding and consequent bruising beneath the patella, in extension of the leg.

The *Ligament of the Patella* is the common tendon of the rectus and triceps extensor muscles of the leg, the patella itself being only a sesamoid bone. It is attached, above, to the anterior edge of the lower border of the patella, descends almost vertically, becoming somewhat narrower, and is inserted into the lower part of the anterior tuberosity of the tibia. It is separated from the cavity of the knee joint by a mass of fat and areolar tissue, and from the prominent point of the tuberosity, over which it glides, by a large bursa, which is said sometimes to communicate with the articular synovial sac.

INTERNAL FEMORAL REGION.

The Muscles of the Internal Femoral Region (with the exception of the gracilis, already described) act upon the thigh itself, and constitute the class of adductors. They are four: the pectineus, long adductor, short adductor, and great adductor. Between these and the upper extremity of the sartorial, may be seen the psoas and iliac muscles as they leave the cavity of the pelvis together beneath the crural arch, having the femoral artery and vein situated along the inner border of the former, and the crural nerve upon the surface of the latter; below the arch, their fibres converge downward and backward to a short, thick tendon, which glides over the prominent point of the small trochanter, a synovial bursa intervening, and is inserted into the back part of the root of this process.

The **Pectineus** (Fig. 165, 2), flattened from before backward, broad

above, and narrow below, arises from the pubic part of the ilio-pectineal line, and the triangular surface of the body of the pubis in front of this line, between the spinous process of the bone and the ilio-pectineal eminence. It descends a little backward and outward, passes over the inner border of the hip joint, and is inserted, by a flat tendon, into the ridge leading from the small trochanter to the rough line of the femur.

Use.—To adduct the thigh, at the same time flexing it, and rotating it outward.

Relations.—It is situated between the psoas and long adductor muscles, is covered above and externally by the femoral vessels and fascia, and lies upon the obturator vessels and nerves, external obturator and short adductor muscles, and the inner part of the capsular ligament of the hip joint, to which latter it is somewhat firmly attached by areolar tissue.

The Long Adductor Muscle (*adductor longus*, Fig. 165, $_7$), triangular, narrow above, and broad below, arises by a short, narrow, flattened tendon from the anterior surface of the pubic bone, between the spinous process and the symphysis. It descends outward and backward, expanding into a broad fleshy belly, and is inserted by a short, broad, flat tendon, into the middle third of the rough line of the femur.

Use.—Same as the preceding.

Relations.—It is placed, *above*, between the gracilis and the pectineus, parallel with the inner border of the latter, and apparently continuous with it. At its insertion it lies between the internal head of the triceps extensor (*vastus internus*) in front, and the great adductor behind, and is here crossed by the sartorial muscle, the femoral artery and vein and long saphenous nerve intervening. It lies upon the short adductor and a part of the great adductor. With the superior third of the sartorial and the crural arch it forms the femoral triangle, through the middle of which pass the femoral artery and vein.

Dissection.—Detach the long adductor from its origin, and turn it downward.

The Short or **Small Adductor Muscle** (*adductor brevis*) is situated beneath the preceding. It arises by a flat tendon from the anterior surface of the pubis, between the gracilis muscle and obturator foramen, expands into a thick, fleshy belly, descends outward, and is inserted into the superior third of the rough line of the femur.

Use.—Same as the two preceding.

Relations.—*In front*, it is in relation with the long adductor and pectineus; *behind*, with the great adductor; *externally*, with the external obturator, psoas, and iliac muscles; *internally*, first with the gracilis, and then with the great adductor, being somewhat blended with the latter.

Dissection.—Detach the short adductor from its origin, and turn it downward and outward.

The **Great Adductor Muscle** (*adductor magnus*) is situated between the three preceding and the muscles upon the back of the thigh. It is the longest and largest of the adductor group, narrow above, but very broad and thick below, and remarkable for the coarseness of its texture, the fleshy bundles being large, and separated from one another by areolar septa. It arises tendinous and fleshy from the anterior surface of the rami of the pubis and ischium, and tendinous from the external border of the tuberosity of the latter. It descends, spreads out like a fan, and is inserted, by an aponeurotic expansion, into the whole length of the rough line of the femur, between its internal and external lips, and by a long, rounded tendon, into a tubercle upon the upper back part of the inner condyle of the femur. The fibres have different directions; those inserted into the upper part of the rough line reach nearly as high as the root of the great trochanter, and pass from their origin outward and a little upward. Below this they have different degrees of obliquity, and those which go to the inner condyle are nearly vertical. Between the last insertion and that into the rough line a considerable interval exists, through which the femoral artery and vein reach the popliteal space behind the knee joint. The insertion into the rough line is blended with the attachments of the internal head of the triceps extensor, long adductor, and short head of the biceps flexor, and is perforated at three or four points for the passage of bloodvessels to and from the posterior part of the thigh.

Use.—Like that of the three preceding, its special function is to carry the thigh inward, but it may also act as an extensor when the thigh is much flexed, and as a flexor when extended; this last being in fact its most common action. When the thigh is the fixed point, it steadies the trunk upon the femur.

Relations.—In front, with the pectineus, long adductor, short adductor, and internal head of the triceps extensor; *behind*, with the biceps flexor, great gluteus, semitendinous and semimembranous muscles, and sciatic nerve; *by its inner border*, first with the gracilis, and then the sartorial; by its *superior border*, with the quadrate or square muscle of the thigh. Its most important relation, however, is with the femoral artery and vein, which, in the lower fourth of the thigh, pass between the two divisions of the insertion of the muscle to reach the ham or popliteal space.

The Vessels and Nerves seen in this dissection are, the femoral artery and vein, and the crural nerve, structures so important that they will be fully described hereafter, under the general subject of Vessels and Nerves of the Lower Extremity, rather than in the region of the thigh to which they appropriately belong.

POSTERIOR PELVIC REGION.

The Muscles situated upon the Posterior and External Surfaces of the Pelvis are all movers of the thigh, and are divided into two groups—extensor and rotator. The extensor group comprises the three gluteal muscles; the rotator group consists of six—the pyriform, internal obturator, external obturator, superior twin, inferior twin, and square femoral. The extensors should be dissected first.

Dissection.—Turn the subject over, place a block transversely beneath the hips, and rotate the thigh inward; then make an incision from the point of the sacrum, following the fold of the buttock to the outer side of the thigh, another along the posterior half of the iliac crest, and a third from the superior iliac spine to the termination of the first. Dissect off first the skin and subcutaneous fat, which latter is generally very abundant in this region, and afterward the fascia that covers the first muscle of the extensor group—the great gluteal—following, as usual, the course of the muscular fibres. The fascia is a continuation of the femoral aponeurosis, is not however very dense, but is very closely attached to the muscle by numerous prolongations, which dip into its substance and separate its coarse bundles from one another. On this account the fascia is rather difficult to remove, for at every stroke of the knife a new process presents itself, until the whole are successively divided; and even when the greatest care has been taken, the muscle has nearly always a ragged, ill-dissected appearance.

The **Great Gluteal Muscle** (*gluteus maximus*, Fig. 167, $_2$) forms the prominent rounded part of the nates. It is very large, flattened, but very thick, and somewhat quadrangular in shape, and remarkable for the coarseness of its texture, being composed of large muscular fasciculi separated from each other by prolongations of the investing fascia. It arises tendinous and fleshy from about two inches of the crest of the ilium behind, and the adjacent rough triangular surface upon the outer aspect of this bone; from the posterior sacro-iliac ligaments and the adjacent surface of the common aponeurosis of the spinal muscles; from the ridge of the sacrum external to the posterior sacral foramina, and from the posterior surface of the coccyx and sacro-ischiatic ligament. From these points the fibres pass outward and downward, forming large angular bundles, nearly parallel, but slightly converging, and are inserted partly into the femoral aponeurosis, upon the outer aspect of the thigh, but principally by a broad, strong tendon, which glides over the great trochanter, into the ridge leading from the great trochanter to the rough line of the femur, and for a short distance into the upper part of this line.

Use.—To extend the thigh, and assist in rotating it outward. Acting from the femur, it is one of the principal muscles that maintain the body in an erect position.

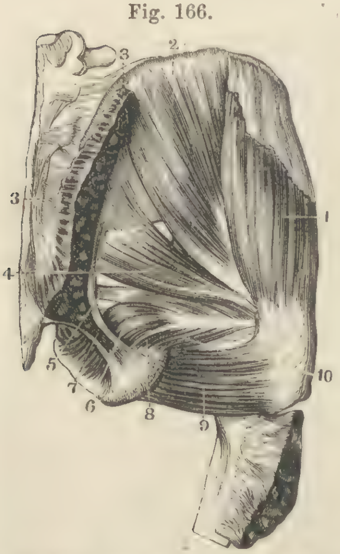
Relations.—It is covered by an expansion of the femoral aponeurosis, and by firm areolar adipose tissue; it covers the posterior part of the

middle gluteal muscle, all of the rotator group, the sacro-ischiatic foramina and their contained structures, the tuberosity of the ischium, the great trochanter, and the upper part of the external head of the triceps. Its superior border is closely connected by the femoral aponeurosis to the surface of the middle gluteal muscle, which it crosses obliquely downward and forward: the inferior forms a marked prominence across the upper back part of the thigh. A large multilocular bursa separates the tendon of the muscle from the trochanter, and sometimes a smaller one is found just below this, where the tendon passes over the upper part of the external head of the triceps; but between the muscular mass and the tuberosity of the ischium over which it lies, there is generally only a quantity of areolar tissue, which, however, in persons accustomed to sit much on hard seats, becomes converted into a true bursa.

Dissection.—Detach the great gluteal from its origins, and turn it outward, so as to examine its deep relations and insertion; then remove it entirely, and dissect the areolar tissue, which is here very abundant, from the subjacent parts. In turning the muscle outward, branches of the gluteal artery, a vessel of considerable size, will be necessarily divided.

The **Middle Gluteal Muscle** (*gluteus medius*, Figs. 166, 1, 2, and 167, 1), broad, thick, and radiated, is more deeply seated than the preceding, but covered by it only behind. It arises from the under surface of the femoral aponeurosis that covers its anterior half, and from the whole of the dorsal surface of the ilium between the anterior three-fourths of the crest and the superior semicircular line, extending as far forward as the anterior superior iliac spine and the subjacent notch, and as far backward as the margin of the sacro-ischiatic notch. From this extensive surface the fibres converge—those in front passing downward and backward, and those behind downward and forward—to a flattened tendon, which, passing over the prominent edge of the great trochanter, is inserted into the whole breadth of the outer surface of this process.

Fig. 166.



Muscles of pelvic region. 1, 2, middle gluteal; 3, cut origin of great gluteal; 4, pyriform; 5, 8, 10, superior and inferior twins (gemelli); 6, 7, internal obturator; 9, square femoral.

Use.—The special action of this muscle is extension of the thigh; but it is also an abductor, and its anterior fibres rotate the femur inward. In the last movement (rotation inward) it acts almost entirely alone; the only

other muscles from which it can possibly derive material assistance are the tensor of the femoral aponeurosis, and the anterior fibres of the small gluteal.

Relations.—It is covered behind by the great gluteal muscle, and in front by the femoral aponeurosis, from the under surface of which a large part of the muscle takes its origin. Its anterior border is overlapped by the tensor of the femoral fascia; its posterior is parallel, and in close contact with the pyriform; its deep surface covers the small gluteal.

Dissection.—Detach the middle gluteal from its origin, and turn it outward, taking care not to remove the pyriform along with it.

The **Small Gluteal Muscle** (*gluteus minimus*), much smaller than, but shaped like the preceding, beneath which it is placed, arises from the whole space upon the dorsal surface of the ilium, between the superior and inferior curved lines; its fibres descend convergingly, and end in a strong, flattened tendon, which is inserted into the anterior half of the upper edge and anterior border of the great trochanter.

Use.—Same as the preceding.

Relations.—It is covered entirely by the middle gluteal, and lies upon the capsular ligament of the hip joint.

The six muscles that rotate the thigh outward are now nearly all *in situ*, and in the same dissection will be observed numerous large arteries and nerves, hereafter to be mentioned.

The **Pyriform Muscle** (Fig. 166, 4), long, flattened, and triangular, originates by its broad extremity within the pelvis, from the anterior surface of the second, third, and fourth pieces of the sacrum external to the anterior sacral foramina; its fibres descending convergingly outward, and a little forward, through the upper part of the great sacro-ischiatic foramen, to a rounded tendon which is inserted into the inner surface of the great trochanter behind.

Relations.—By its anterior or internal surface it is in relation in the pelvis, with the rectum, sacral plexus, and sciatic nerve, and, without the pelvis, with the hip joint. Its posterior surface is in contact with the outer border of the sacrum, and covered by the great gluteal muscle. Its upper or external border is parallel and in close contact with the lower border of the middle gluteal muscle, the gluteal vessels and nerves passing between them above. Its lower border is separated from the superior twin muscle by the great and small sciatic nerves and sciatic vessels which here leave the cavity of the pelvis. The great sciatic nerve often perforates the muscle.

The **Twin Muscles** (*gemelli*, Fig. 166, 5, 8, 10) are two small fleshy slips, connected with the tendon of the internal obturator. The *superior* arises from the spine of the ischium, the *inferior* from the tuberosity;

they both pass horizontally outward, and are inserted with the above tendon, which they closely embrace, into the digital fossa at the base of the great trochanter.

Relations.—They are covered by the great gluteal muscle, crossed behind from above downward by the great and small sciatic nerves and accompanying vessels, and in contact in front with the posterior surface of the capsular ligament of the hip joint.

Dissection.—Divide the great sciatic nerve two or three inches below, and dissect the twin muscles off, to show the tendon of the internal obturator which lies between. The fleshy portion of this muscle has been already seen in the dissection of the interior of the pelvis.

The **Internal Obturator Muscle**, flattened but thick, triangular in form, and situated partly within and partly without the cavity of the pelvis, arises from the internal surface of the obturator membrane and the borders of the obturator opening. The fibres converge downward and outward, toward the smaller sacro-ischiatic foramen, where they end in a number of tendinous slips, which are reflected at a right angle over the pulleylike surface of the ischium, between its spine and tuberosity, a large bursa intervening. These slips end in the rounded tendon, which is inclosed by the twin muscles, and inserted into the digital fossa at the root of the great trochanter. In order to see the tendinous slips and the smooth surface over which they glide, the tendon must be detached from its insertion and turned outward.

Relations.—Within the pelvis it lies anterior and external to the contained organs, and is covered by the tendinous arch that gives origin to the elevator muscle of the anus, and by the pelvic fascia. In leaving the cavity of the pelvis, it occupies the smaller sciatic foramen, in common with the internal pudic vessels and nerve; external to the pelvic cavity, it is covered by the great gluteal muscle, crossed by the great sciatic nerve and accompanying vessels, lies upon the posterior surface of the hip joint, and is inseparably blended with the twin muscles.

The **Square Femoral Muscle** (*quadratus femoris*, Fig. 166, $_9$) is situated below the tendon of the preceding. It is flattened antero-posteriorly, quadrangular, as its name indicates, about two and a half inches long and one and a half broad, and almost entirely fleshy. It arises from the external border of the tuberosity of the ischium, passes transversely outward, and is inserted into the posterior border of the great trochanter and posterior intertrochanteric line.

Relations.—It is covered by the great gluteal muscle, crossed by the great sciatic nerve and accompanying vessels, and covers the external obturator muscle and the posterior surface of the hip joint. Its lower border is parallel to and in contact with the superior border of the great adductor muscle, of which it often seems to be a part.

Dissection.—Detach the square muscle from its origin and insertion, and dissect off the subjacent areolar tissue, and the external obturator will be brought into view.

The **External Obturator Muscle** is triangular pyramidal, with its base presenting toward the pelvis, and thinner and smaller than the internal obturator. It arises fleshy from the anterior or external surface of the obturator membrane, and the adjoining surfaces of the bones that form the obturator foramen. The fibres converge outward and backward to a fleshy belly, which turns obliquely around the neck of the femur, in a sort of notch between the tuberosity of the ischium and acetabulum. Here a strong tendon is formed, which passes horizontally outward, between the inferior twin muscle and the capsular ligament of the hip joint, and is inserted into the lowest part of the digital fossa, at the root of the great trochanter.

Relations.—It is covered anteriorly by the adductor, psoas, and iliac muscles, and obturator nerve and vessels; externally, by the capsular ligament and neck of the femur; and posteriorly, by the square and inferior twin muscles.

Uses.—The special action of the preceding six muscles is rotation of the thigh outward. It is necessary, however, for the performance of this movement, that the limb should be either straight or extended; for when semiflexed, as in the sitting posture, they are abductors. Acting from the femur as a fixed point, they turn the trunk toward the opposite side. Some of them are closely connected with the capsular ligament of the hip joint, and thus probably prevent the folding of this structure between the head of the bone and margin of the acetabulum.

Vessels and Nerves.—The *arteries* observed in dissecting the posterior pelvic region are: 1, the *gluteal artery*, a vessel of considerable size, which passes out of the highest part of the great sacro-ischiatic foramen, and divides into branches, to supply the three gluteal muscles; 2, the *sciatic artery*, but little smaller than the gluteal, which emerges at the lower part of the great sciatic foramen, in company with the great sciatic nerve, and is distributed to the muscles upon the lower back part of the hip and upper back part of the thighs; 3, the *internal pudic artery*, which leaves the pelvic cavity at the lower part of the great sciatic foramen, passes over the posterior surface of the spine of the ischium, and enters the cavity again through the small sciatic foramen, to reach the deep part of the perineum and root of the penis. *Veins* accompany the several arteries, and terminate in the internal iliac vein.

The *nerves* are: 1, the *superior gluteal nerve*, which accompanies the gluteal artery, and is distributed principally to the middle and small gluteal muscles; 2, the *inferior gluteal*, which emerges from the pelvis beneath the pyriform muscle, and is distributed to the great gluteal mus-

cle; 3, the *small sciatic*, which originates by a common trunk with the preceding, passes from the pelvis beneath the pyriform muscle, and is distributed principally to the skin over the tuberosity of the ischium and back of the thigh; 4, the *pudic*, which accompanies the internal pudic artery and its branches; 5, the *great sciatic*, the largest nerve in the body, which leaves the pelvic cavity beneath the pyriform muscle, and descends upon the twin, internal obturator, and square muscles, midway between the great trochanter and tuberosity of the ischium, to the back of the thigh, whence it descends to the leg and foot, as will be hereafter seen.

POSTERIOR FEMORAL REGION.

The Muscles situated upon the Posterior Region of the Thigh are the biceps, semitendinous, and semimembranous, cammonly called the hamstring muscles, and all flexors of the leg. The popliteal, the other muscle belonging to this group, is situated upon the back of the leg.

Dissection.—Divide the skin by an incision extending from the ischiatic tuberosity to the middle of the lower part of the ham, where it may be intersected by another, extending transversely across the upper back part of the leg. Dissect aside the skin and subcutaneous areolar adipose tissue, and the continuation of the femoral aponeurosis that covers the muscles of this region will be brought into view. The aponeurosis is not nearly so dense as upon the outer or anterior aspect of the limb, but increases in strength from above downward. It is attached above to the tuberosity of the ischium, dips down upon each side to reach the rough line of the femur, sends processes or sheaths to the subjacent muscles, and is continuous, below the ham, with the fascia of the leg.

Turn aside the fascia, and dissect the areolar and adipose tissue cleanly from the muscles and popliteal space.

The **Biceps Flexor Muscle of the Leg** (*biceps flexor cruris*, Fig. 167, 3), a long, large muscle, situated upon the outer back part of the thigh, has, as its name indicates, two heads, of which one is longer than the other. The *long head* originates from the upper back part of the tuberosity of the ischium by a thick, strong tendon, common to it and the semitendinous muscle, descends a little outward, leaves the latter muscle about two or three inches below the tuberosity, expands into a fusiform, fleshy belly, and at the inferior third of the thigh unites with the *short head*, which arises fleshy from the middle three-fifths of the rough line of the femur, and descends backward and a little inward, in the form of a rounded fleshy mass. The two form a common strong tendon (the external hamstring), which descends behind the outer condyle of the femur, turns forward, and is inserted into the head of the fibula, and by an aponeurotic expansion into the head of the tibia.

Use.—To flex the leg, and, secondarily, to extend the thigh. Acting from the leg as a fixed point, it steadies the thigh and pelvis, and bends the latter backward upon the hip joint.

Relations.—The common tendon of the biceps and semitendinous mus-

cles is covered by the great gluteal muscle, and separated from the tuberosity of the ischium by a bursa; from the point where the two separate, the long head of the biceps lies, at first, upon the posterior surface of the semitendinous, but gradually leaves it to the inner side, and passes over the great sciatic nerve and the short head; the common tendon of the two heads crosses the external articular vessels and external head of the gastrocnemius muscle, and forms the outer boundary of the popliteal space.

Fig. 167.

Muscles of back of thigh. 1, middle gluteal; 2, great gluteal; 3, biceps flexor of leg; 4, tendon of semitendinous; 5, semimembranous; 6, semitendinous.

The **Semitendinous Muscle** (Fig. 167, 6) arises from the upper back part of the tuberosity of the ischium, by a common tendon with the long head of the biceps; the muscular fibres originate from the outer side of the tendon for the distance of two or three inches, and form a large fusiform belly, which descends a little outward, and about three inches above the knee joint terminates in a long rounded tendon, which passes behind the internal condyle of the femur, turns around the internal tuberosity of the tibia, and is inserted into the anterior tuberosity of the tibia, behind the tendon of the sartorial, and below that of the gracilis; the lower or convex edge of the tendon is connected with the fascia of the leg.

Use.—To flex the leg and rotate it slightly inward, or, acting from the leg, to steady the pelvis on the hip joint, and bend it backward; as a secondary effect, it may assist in flexing the thigh on the pelvis.

Relations.—It is covered superiorly by the great gluteal muscle, is superficial in the rest of its course, and rests upon the semimembranous.

The **Semimembranous Muscle,** situated beneath the preceding, arises from the upper back part of the tuberosity of the ischium, beneath the common origin of the biceps and semitendinous, by a strong flat tendon, which descends and spreads out into an aponeurotic lamina. From the inner surface of this lamina, the fleshy fibres originate as low down as the middle third of the thigh, and pass obliquely inward to the outer surface of a corresponding lamina below, which descends, narrows to a thick tendon that passes behind the internal condyle of the femur, and divides

into three parts: one of these divisions, broad and thin, being reflected upward and backward beneath the internal head of the gastrocnemius, and across the posterior surface of the knee joint, to be inserted into the external condyle of the femur, constituting what is commonly called *Winslow's ligament* or the *posterior ligament* of the knee joint; another, also aponeurotic, expanding over the popliteus muscle to be inserted into the posterior surface of the head of the tibia; and the third turning forward beneath the internal lateral ligament of the knee joint, to be inserted into the inner tuberosity of the tibia, behind the insertion of the gracilis and semitendinous.

Use.—To flex the leg and rotate it inward, and, secondarily, to extend the thigh; when the leg is the fixed point, it steadies the trunk upon the femur, and assists in bending it backward at the hip joint.

Relations.—It is covered above by the semitendinous, biceps, and great gluteal muscles, and crosses the great adductor and square muscles; below, it is superficial, external to the semitendinous, slightly overlaps the popliteal vessels, and is parallel with the great sciatic nerve which lies along its outer border.

Upon the back of the thigh, between and beneath the preceding three muscles, is a long narrow interval occupied by loose areolar tissue, communicating, above, with the pelvis at the great sciatic foramen, and, below, with the popliteal space or ham of the leg. This interval is traversed its whole length by the great sciatic nerve, and is the track along which purulent matter sometimes travels, from the cavity of the pelvis or upper back part of the thigh to the popliteal space.

No very large or important bloodvessels are seen in this dissection until we reach the popliteal space, the contents of which will be hereafter described.

The *Great Sciatic Nerve*, here brought into view, is the largest nerve in the body. It originates from the sacral plexus, leaves the pelvic cavity at the great sciatic foramen, and makes its appearance upon the back of the thigh below the inferior border of the pyriform muscle, whence it descends vertically to the upper angle of the popliteal space. In the first part of its course it lies midway between the tuberosity of the ischium and the great trochanter; crosses the twin muscles, tendon of the internal obturator, and the square femoral muscle, and is covered behind by the great gluteal muscle. Below this point it traverses the long areolar interval between the three hamstring muscles and the posterior surface of the great adductor, and is crossed very obliquely from above downward and outward by the long head of the biceps.

In its course it gives off several cutaneous and muscular twigs, and in the lower third of the thigh splits into two branches, one of which, called the *tibial* or *popliteal nerve*, continues straight on through the popliteal

space to the back of the leg; and the other, the *peroneal nerve*, turns around the outer side of the knee, and crosses the upper extremity of the fibula to reach the front of the leg. This bifurcation of the sciatic nerve frequently occurs much higher up, and sometimes even within the pelvis. In the latter case, the two divisions either emerge together beneath the pyriform muscle, or one passes below, and the other above or through the substance of the muscle. In either case, the two follow the same course to the popliteal space, lying side by side, and separated only by a narrow areolar interspace.

CRURAL REGION.

The Muscles of the Leg consist of three groups, anterior, external, and posterior. The anterior group comprises three muscles, the anterior tibial, the long common extensor of the toes, and the extensor of the great toe. These are situated upon the Anterior Crural Region, between the tibia and fibula, and upon the interosseous membrane, and should be dissected first.

Dissection of the Anterior Crural Region.—First detach the limb from the pelvis by cutting through the coxo-femoral articulation, and remove all of the muscles from the femur, dividing those that are attached to the leg, within two or three inches of their insertion; then divide the skin by a long incision, extending from the anterior tuberosity of the tibia, along the external border or spine of this bone to the ankle, and thence along the inner margin of the top of the foot to the extremity of the great toe; reflect the skin and subcutaneous areolar tissue outward as far as the external border of the leg and foot, so as to expose the subjacent aponeurosis.

The **Crural Aponeurosis** of the anterior region is tolerably dense and strong, continuous above with the aponeurosis of the thigh, and with the tendons of the sartorial, gracilis, semitendinous, semimembranous, and biceps muscles, and is attached, above, to the head of the fibula and tibia. From these points it descends upon the front of the leg, having a close attachment to the spine of the tibia and to the origins of the anterior muscles; becoming thinner as it descends, it spreads out over the muscles of the fibular region to reach the back of the leg, and, increasing in density at the ankle, forms what is called the *anterior annular ligament* (Fig. 168). This ligament, often but improperly considered a separate structure, is attached, internally, to the malleolar process of the tibia and the scaphoid bone, and, externally, to the external malleolus and upper part of the calcaneum. It binds the tendons of the anterior tibial and two extensor muscles in their places; and from its under surface two processes, attached to the ligamentous structures about the joint, are given off to form three separate sheaths, for the accommodation of the tendons. Upon the upper or dorsal surface of the foot the fascia is thin and com-

paratively weak, and attached, externally and internally, to the bones forming the corresponding borders of the foot.

Dissection.—Divide the fascia just above the ankle so as to leave the annular band; cut it also from the spine of the tibia its whole length, and reflect it outward. In doing this, it is necessary to carry the edge of the knife close to its under surface in the upper part of the region, for here, as before mentioned, it is closely attached to the subjacent muscles; in fact, the muscles partly originate from its under surface.

The **Anterior Tibial Muscle** (*tibialis anticus*, Fig. 168, 3) is long and tapering, and situated in front of the leg along the outer surface of the tibia. It arises fleshy from the tuberosity and upper two-thirds of the outer surface of this bone, from the adjacent part of the interosseous membrane, and from the under surface of the crural fascia above. It descends almost vertically, and in the lower third of the leg terminates in a long and somewhat flattened tendon, which passes through a separate ring beneath the annular ligament, inclines inward over the forepart of the lower extremity of the tibia, crosses the astragalus and scaphoid bones, and is inserted into the inner side of the large cuneiform bone, and the contiguous end of the first metatarsal bone.

Use.—To flex the foot, also to adduct it and raise its inner border; acting from the foot, it steadies the leg at the ankle joint.

Relations.—It is covered throughout its whole length by the crural fascia, and lies upon the outer surface of the tibia in the upper two-thirds of its extent, and, below, upon the anterior surface of this bone; externally, it is in contact with the long extensor of the toes and extensor of the great toe, the anterior tibial vessels and nerve intervening, but situated deep upon the anterior surface of the interosseous membrane.

The **Long Extensor Muscle of the Toes** (*extensor longus digitorum pedis*, Fig. 168, 4), situated upon the outer side of the preceding, is long, thin, and flattened from side to side. It arises fleshy from the upper two-thirds of the anterior surface of the fibula, from the interosseous membrane, and from the crural fascia, and terminates just above the ankle in three tendons which pass beneath the anterior annular ligament. On the top of the foot the external tendon splits into two, making the whole number four; these proceed toward the four smaller toes, at the bases of which they are joined by the tendons of the short extensor, and, forming a fibrous expansion over the first phalanges, are inserted into the bases of the second and third phalanges. Before reaching the toes, the tendons are connected together by little fibrous slips that proceed from one to another.

Use.—To extend the toes, and, secondarily, to flex the foot; acting from the foot, it assists in steadying the leg at the ankle joint.

Relations.—It is covered by the crural fascia, and is in contact, inter-

nally, with the anterior tibial muscle and the extensor of the great toe; externally, with the peroneal muscles, the shortest one of which seems to be only an offset from the extensor; and its tendons cross those of the short extensor upon the upper surface of the foot, obliquely, from within outward.

Fig. 168.

Muscles of front of leg and back of foot. 1, tendon of rectus muscle of thigh; 2, subcutaneous inner surface of tibia; 3, anterior tibial muscle; 4, long extensor of toes; 5, extensor of great toe; 6, anterior peroneal muscle; 7, long peroneal muscle; 8, short peroneal muscle; 9, borders of soleus; 10, border of inner belly of gastrocnemius; 11, short extensor of toes, beneath tendons of long extensor.

The **Extensor Muscle of the Great Toe** (*extensor proprius pollicis pedis*, Fig. 168, $_5$), situated between the two preceding, is long, narrow, and flattened from side to side. It arises fleshy from the middle third of the internal surface of the fibula, and from the adjacent interosseous membrane, and descends as far as the ankle, where it terminates in a long, narrow tendon, which, passing beneath the anterior annular ligament and along the upper surface of the foot, spreads out into an aponeurosis over the first joint of the great toe, and is inserted into the base of its second phalanx.

Use.—To extend the great toe, and, secondarily, to assist in flexing the foot.

Relations.—On the leg, it lies between the two preceding muscles, and external to the anterior tibial artery, but, on the upper surface of the foot, it is placed to the inner side of this vessel, having crossed it obliquely just below the ankle joint.

The **Short Extensor Muscle of the Toes** (*extensor brevis digitorum pedis*, Fig. 168, $_{11}$), although belonging to a different region from the three preceding muscles, is necessarily exposed by the same dissection, and may as well be studied in this connection. It is situated upon the upper surface of the foot, and consists of a broad, thin, fleshy layer, which arises from the superior surface of the calcaneum and calcaneo-astragalous ligament, passes forward and a little inward, and terminates in four small tendons, which become continuous with the tendons of the long extensor at the base of the toes.

Use.—To assist in extension of the toes.

Relations.—Superficially, it is in relation with the tendons of the long extensor, the two sets crossing obliquely; by its deep surface, with the bones and ligaments of the foot.

Vessels and Nerves.—The *anterior tibial artery* is a branch of the popliteal, but its distribution, as well as that of the *peroneal nerve*, also seen in this dissection, will be fully described in connection with the Vessels and Nerves of the Lower Extremity (p. 378).

Dissection of the External Crural Region.—Reflect the flap of skin, which has been already taken from the anterior surface of the leg, farther outward, and observe the disposition of the crural fascia, especially at the ankle joint, where it stretches across from the external malleolar process to the calcaneum, forming what is called the *external annular ligament*, and confining the tendons of the long and short peroneal muscles. Just above the ankle, the fascia is perforated by several cutaneous branches of the peroneal nerve. Next, dissect the fascia from the surface of the muscles, leaving the annular ligament in its place.

The Peroneal or Fibular Group of muscles consists of three, named from their situation and relative size, the long, short, and small peroneal.

The **Long Peroneal Muscle** (*peroneus longus*, Fig. 168, 7), long and narrow, and tendinous in the lower half of its extent, arises fleshy from the upper two-thirds of the external surface of the fibula, from the under surface of the crural fascia, and from the aponeurotic septa which separate the muscles of this region from those on the anterior and posterior portions of the leg. It descends vertically upon the outer aspect of the fibula, and in the lower third of the leg terminates in a long tendon, which passes in a groove behind the malleolar process of the fibula, occupying a sheath beneath the external annular ligament in common with the short peroneal muscle; it then turns beneath the outer border of the foot, enters the groove upon the under surface of the cuboid bone, passes forward and inward across the bottom of the foot, and is inserted into the base of the first metatarsal bone. Its course beneath the foot cannot be seen until revealed by the dissection of this region.

Use.—To extend the foot at the ankle joint and evert its lower surface; the latter action is not very evident in the natural state of the parts, but in fracture of the lower extremity of the fibula, the check to the movement of the ankle in this direction being thus in a great measure removed, it is very remarkable; acting from the foot, especially in standing on one foot, it prevents the weight of the body from inclining the leg inward.

Relations.—It is covered by the fascia of the leg, and lies upon the short peroneal muscle and upper part of the bone between the muscles of the anterior and posterior regions; in the sole of the foot it is placed in contact with the bones, and consequently above all the muscles of this region.

The **Short Peroneal Muscle** (*peroneus brevis*, Fig. 168, 8), exposed by the removal of the long peroneal, arises fleshy from the lower half of the external surface of the fibula and the intermuscular fascia on each side, descends vertically, and terminates, just above the external malleolus, in a flattened tendon which passes behind this process in the same groove and sheath with the preceding muscle, turns forward, passes through a special groove in the calcaneum, and is inserted into the base of the last metatarsal bone.

Use.—To extend the foot and to assist slightly in everting it; acting from the foot it assists the long peroneal in steadying the leg at the ankle joint.

The **Small Peroneal Muscle** (*peroneus tertius*) is intimately connected with the long extensor muscle of the toes, of which it is often considered as an offset. It arises fleshy from the lower third of the forepart of the fibula and adjacent surface of the interosseous membrane, descends, and terminates in a small tendon which passes beneath the anterior annular ligament in common with the tendons of the long extensor of the toes, and is inserted into the base of the fifth metatarsal bone. Sometimes it is inserted into the fourth metatarsal bone, and sometimes it is wanting.

Use.—To flex the foot and assist slightly in its eversion.

Dissection of the Posterior Crural Region.—The skin having been already removed from the front and outer surface of the leg, may be dissected from the posterior surface by turning it from either one side or the other, as far down as the inner side of the foot, so as to expose the fascia of this region, and the main trunk of the external or short saphena vein which lies upon its surface. (See p. 379.)

The *Fascia* upon the back of the leg is thin, and blended near the heel with the subjacent areolar tissue and the fascia that covers the deep group of muscles. Upon the inner side of the ankle it forms a broad and tolerably thick band called the *internal annular ligament*, which stretches from the malleolar process of the tibia to the lower back part of the calcaneum, forming an arch in this situation beneath which pass the tendons of the deep muscles, and the posterior tibial vessels and nerve; above, it is continuous with the femoral aponeurosis over the popliteal space, and, on each side, with the fascia that separates the superficial from the deep muscles. About midway between the knee and heel, it is perforated by the short saphenous nerve.

The Muscles upon the Back of the Leg form a superficial and a deep group, each consisting of three muscles. The three *superficial* are the gastrocnemius, soleus, and plantaris; the *deep* are the posterior tibial, common flexor of the toes, and long flexor of the great toe. This grouping of the muscles of the leg into threes will greatly aid the student in remembering their relative position. As he has already seen, the anterior tibial group consists of three—the anterior tibial, long extensor of the toes, and long extensor of the great toe; the fibular or peroneal group of

three—the long, short, and small peroneal muscles; and the posterior tibial group is subdivided into a superficial and deep, each consisting of three, as above mentioned.

Dissection.—Remove all the fascia except where it constitutes the internal annular ligament, and the posterior surface of the gastrocnemius muscle and the tendon of Achilles will be brought into view.

The **Gastrocnemius Muscle**, so called because it forms the greater part of the calf of the leg, broad and thick, arises from the lower part of the femur, just above its condyles, by two separate tendinous heads, which form the lower boundary of the popliteal space, and, descending, become spread out into a glistening aponeurosis. From the under surface of these expanded tendons, the muscular fibres proceed downward and forward, constituting two large fleshy bellies, and are inserted into the posterior surface of another broad aponeurosis, which narrows as it descends, and, having united with the soleus muscle, is inserted through the tendon of Achilles into the lower back part of the calcaneum.

Fig. 169.

Superficial muscles of posterior crural region. 1, biceps muscle forming outer hamstring; 2, tendons forming inner hamstring; 3, popliteal space; 4, gastrocnemius muscle; 5, soleus; 6, Achilles' tendon; 7, posterior tuberosity of heel bone; 8, tendons of long and short peroneal muscles passing behind outer malleolus; 9, tendons of posterior tibial and long flexor of toes passing into foot behind inner malleolus.

Relations.—The gastrocnemius is covered by the crural fascia, and has lying upon the middle of its superficial surface, between the two fleshy bellies, the short saphenous vein and nerve; it covers in the plantaris, soleus, and popliteal muscles. Its two heads are inclosed by the hamstring muscles, but separated by the popliteal vessels and posterior tibial nerve; they pass over the condyles as upon pulleys, synovial bursæ intervening, and generally contain a sesamoid fibro-cartilage imbedded in their under surface.

Dissection.—Detach the two heads of the gastrocnemius and turn the muscle down, taking care not to raise along with it the plantaris, the small fleshy belly of which is in close contact with the external head.

The **Soleus Muscle**, broad, thick, and oval, arises by tendinous fibres from the superior third of the posterior surface of the fibula, from the lower edge of the oblique ridge on the posterior surface of the tibia, and about two inches of bony surface below the ridge, and from a tendinous arch stretched between the tibia and fibula in this situation for the protection of the posterior tibial vessels and nerve; the fibres descend slightly backward, soon become fleshy, and

terminate upon the deep surface of a broad aponeurosis, which narrows from above downward, and in the lower part of the leg joins the gastrocnemius to form the tendon of Achilles. The muscle continues fleshy lower than the gastrocnemius, and is completely covered by the latter, except a little strip on each side just above the tendon.

The *Tendon of Achilles* (tendo Achillis), formed by the union of the tendons of the gastrocnemius and soleus muscles, is the strongest and thickest tendon in the body. It is about two inches long, broad and thin above, thick and contracted in the middle, and expanded again below, and inserted into the tuberosity of the calcaneum, a synovial bursa intervening between the upper part of the bone and the surface of the tendon. It is covered by the fascia and skin, and separated from the deep muscles and vessels by a considerable interval, occupied by fat and areolar tissue. Its comparatively isolated position renders its division, for the cure of club-foot, easy and free from danger.

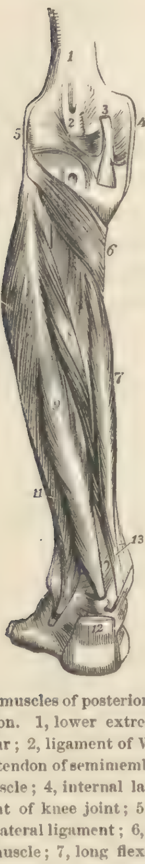
The **Plantaris Muscle** consists of a small, pyriform, fleshy belly, about two inches long, and a very long delicate tendon. It arises from the femur, immediately above the external condyle, descends behind the corresponding head of the gastrocnemius, and terminates in a long, narrow tendon, which passes between the gastrocnemius and soleus, inclining a little inward, and, having gained the inner border of Achilles' tendon, continues in this connection to the heel bone. It sometimes terminates in the latter tendon, and is often wanting.

The gastrocnemius and soleus are among the most powerful muscles in the body. Their special action is to extend the foot, in doing which, the sole remaining on the ground, as in walking or standing on tiptoe, they raise the whole weight of the body. They are brought powerfully into action in running, jumping, dancing, etc., and, in violent efforts, have been known not unfrequently to rupture the tendon, or to tear away the back part of the calcaneum. In addition to its action on the foot, the gastrocnemius may, in consequence of its connection with the femur, be made to assist in flexing the leg. Acting from the foot, they both steady the leg at the ankle joint, and the gastrocnemius assists in steadying the femur at the knee joint. The plantaris is an accessory to the gastrocnemius, but of very little force.

The **Popliteal Muscle** (Fig. 170, 6) is situated upon the upper back part of the leg, beneath the gastrocnemius, but belongs, with the semimembranous, biceps, etc., to the group of flexors of the leg. It is flat and triangular, arises by a thick tendon nearly an inch long from a small pit upon the outer surface of the external condyle of the femur, passes obliquely downward and inward, in close contact with the knee joint, spreads out, and is inserted into the triangular surface of the tibia, above the oblique line.

Use.—To flex the leg and rotate it inward, but mainly to strengthen the knee joint.

Fig. 170.



Deep muscles of posterior tibial region. 1, lower extremity of femur; 2, ligament of Winslow; 3, tendon of semimembranous muscle; 4, internal lateral ligament of knee joint; 5, external lateral ligament; 6, popliteal muscle; 7, long flexor of toes; 8, posterior tibial muscle; 9, long flexor of great toe; 10, long peroneal muscle; 11, short peroneal; 12, Achilles' tendon divided near its insertion; 13, tendons of posterior tibial and long flexor of toes, just as they are about to pass beneath internal annular ligament; interval between latter tendon and tendon of long flexor of great toe is occupied by posterior tibial vessels and nerve.

Relations.—It is covered by a strong fibrous expansion from the tendon of the semimembranous, which separates it from the gastrocnemius. Its tendon is attached to the external semilunar cartilage of the knee joint, which is sometimes grooved for its accommodation; is invested internally by the synovial membrane, and crossed externally, near its origin, by the external lateral ligament.

The Deep Group of Muscles upon the back of the leg consists of the long flexor of the toes, the long flexor of the great toe, and the posterior tibial. They are covered by a thin fascia stretched between the two bones, continuous above with the fascia that covers the popliteal muscle, and below with the internal annular ligament. To expose them, it is only necessary to detach the soleus and gastrocnemius, and dissect off the intermuscular fascia. Their insertions, however, take place upon the bottom of the foot, and cannot at present be seen.

The **Long Flexor Muscle of the Toes** (*flexor longus digitorum pedis*, Fig. 170, 7) arises fleshy from the posterior surface of the tibia below the oblique line, to within two or three inches of the ankle joint, and from the adjacent part of the interosseous membrane; the fibres descend backward to a tendon, which passes behind the malleolar process of the tibia along with the tendon of the posterior tibial muscle, and beneath the internal annular ligament, then turns forward in a groove on the astragalus and calcaneum, and about the middle of the sole of the foot splits into four terminal tendons. These pass to the four smaller toes, beneath which they perforate the tendons of the short flexor, which are split for the purpose, and, traversing a fibrous sheath formed upon the under surface of the first and second phalanges of each toe, are inserted into the base of the last phalanx. In its course through the sole of the foot, the tendon receives upon its outer side an accessory muscular mass originating from the calcaneum,

and crosses, beneath the tendon of the flexor of the great toe, a tendinous slip connecting the two.

Use.—To flex the phalanges of the toes, and, secondarily, to extend the foot.

The pedal portion of this muscle, as well as that of the others of this group, cannot be seen until the foot is dissected.

The **Long Flexor Muscle of the Great Toe** (*flexor longus pollicis pedis*) arises fleshy from the lower two-thirds of the posterior surface of the fibula, from a small part of the interosseous membrane, and from the intermuscular septa. A tendon is formed upon the posterior surface of the muscle, which descends along a separate groove upon the posterior surface of the internal malleolus, turns forward, runs along a groove upon the astragalus and tubercle of the calcaneum, passes along the under surface of the first metatarsal bone between the two heads of the short flexor, and, having traversed a vaginal sheath which binds it to the inferior surface of the first phalanx, is inserted into the base of the second.

Use.—To flex the great toe, and assist in extending the foot.

The **Posterior Tibial Muscle** (*tibialis posticus*, Fig. 170, $_8$) is situated upon the back of the leg, between the two preceding, and is divided at its superior extremity into two short lateral slips, between which the anterior tibial vessels perforate the interosseous membrane, to reach the front of the leg. It arises fleshy from nearly the whole length of the posterior surface of the interosseous membrane, the adjacent borders of the fibula and tibia, and the intermuscular septa, and terminates below in a strong tendon, which traverses a groove upon the posterior surface of the internal malleolus in common with the long flexor of the toes, crosses above this tendon, and proceeds, forward and inward, to be inserted into the inferior and internal part of the scaphoid and internal cuneiform bones.

Use.—To extend the foot.

REGION OF THE FOOT.

There are twenty different muscles in the Region of the Foot (see classification, page 350), all of which, with the exception of the short extensor of the toes, are situated upon the plantar surface and between the metatarsal bones. Although very interesting in a physiological point of view, they possess but little practical importance, and the student is advised not to spend much time in their dissection, nor to burden his mind with the recollection of the details of their origin and insertion, unless his object is to become an accomplished anatomist. Still, he should not neglect to dissect this region with some care, for, besides the general knowledge he may obtain of the relative position of the different parts

he has yet to see the insertions of several of the muscles of the leg already described.

Dissection of the Plantar Surface of the Foot.—Commence upon either border of the foot, and carefully remove the skin and the subcutaneous layer of dense areolar adipose tissue intervening between it and the plantar aponeurosis. The thickness of this adipose layer varies according to the general condition of the body, but it is never entirely wanting, even in the most emaciated persons, and is remarkable for its firmness and the great strength of the areolar processes or bands, which traverse it and are connected to the skin and subjacent aponeurosis. To dissect this layer clean from the surface of the aponeurosis requires much care and perseverance.

The **Plantar Aponeurosis** is a thick, strong, fibrous membrane, covering the muscles of the bottom of the foot, irregularly triangular in shape, narrow behind, where it is attached to the under surface of the calcaneum, and expanded in front over the ball of the foot. It consists of three divisions; an *internal*, which is thin, covering the abductor muscle of the great toe, and liable to be removed along with the skin; an *external*, thick and strong, covering the corresponding border of the foot; and a *central* portion, situated between the two. It is continuous on each side with the fascia of the dorsal surface of the foot, covered below by the dense, subcutaneous, adipose layer, and intimately connected by its upper surface with some of the muscles of this region. Its anterior expanded extremity reaches as far as the roots of the toes, where it is attached by little slips to the sides of the metatarso-phalangeal articulations. It also sends three longitudinal processes from its upper or deep surface, which are attached to the bones of the foot, and separate the outer, middle, and internal divisions of this region from one another.

Dissection.—Remove the plantar aponeurosis, by turning it from before backward, taking care to carry the knife close to its deep surface, since some of the muscles take their origin partly from this surface behind.

The **Short Flexor Muscle of the Toes** (*flexor brevis digitorum pedis*), narrow behind and broad in front, is situated in the middle of the sole of the foot, between the plantar aponeurosis and the deep muscles. It arises tendinous and fleshy from the middle of the lower surface of the calcaneum, internal annular ligament, deep surface of the plantar aponeurosis, and intermuscular septa, and, passing forward, becomes somewhat spread out, and divides into four slips which soon terminate in as many delicate tendons. The latter proceed forward, and, diverging slightly, enter the fibrous sheaths upon the first and second phalanges of the toes, along with the tendons of the long flexor, and upon the under surface of the second phalanges each one splits, for the passage of the long tendons, into two slips, which, uniting again around the tendon, are inserted together into the second phalanx.

Use.—To assist in flexing the toes.

The **Abductor Muscle of the Great Toe** (*abductor pollicis pedis*), long, narrow, and situated upon the under surface of the internal border of the foot, arises by two heads; one (the long head) from the internal surface of the tuberosity of the calcaneum and the plantar aponeurosis, and the other (the short head) from the external cuneiform and first metatarsal bones; it proceeds forward, and terminates in a flat tendon which is inserted into the internal side of the first phalanx of the great toe, and into a sesamoid bone in this situation.

Use.—To abduct the great toe from the smaller toes.

The **Abductor Muscle of the Small Toe**, long, narrow, situated near the outer border of the foot, arises tendinous and fleshy from the outer side of the calcaneum, under surface of the fifth metatarsal bone, and plantar aponeurosis, proceeds forward, and is inserted by a short tendon into the base of the first phalanx of the small toe upon its outer aspect.

Use.—To separate the small toe from the others.

Dissection.—The three preceding muscles form a superficial layer, covered below by the plantar fascia, and must be removed by detaching them from their posterior attachments, and reflecting them forward. By this means the tendons of the long flexor of the toes, with its accessory muscle and the long flexor of the great toe, will be brought into view. These, having been examined, may also be turned forward, and the deep muscles will be brought into view.

The **Accessory Muscle** (*musculus accessorius*), a flat square mass of fleshy fibres, arises from the inferior and lateral borders of the calcaneum, proceeds forward, and is inserted into the outer border of the tendon of the common long flexor of the toes, just before its division.

Use.—To correct the obliquity of the tendon of the long flexor, and assist in flexing the toes.

The **Lumbricales** are four narrow, rounded, muscular slips, which arise from the angles of the tendons of the long flexor of the toes, proceed forward, and are inserted into the internal side of the first phalanges of the four smaller toes.

Use.—To adduct and assist in flexing the toes.

The **Short Flexor Muscle of the Great Toe** (*flexor brevis pollicis pedis*), situated along the outer border of the abductor, with which it is intimately connected, arises by a strong tendon from the calcaneum and external cuboid bone, proceeds forward, expands into a fleshy belly, and is inserted into the base of the first phalanx of the great toe by two short tendons, one on each side of the tendon of the long flexor. A sesamoid bone is found in each of the two tendons, where they pass over the head of the first metatarsal bone.

Use.—To assist the long flexor.

The **Adductor of the Great Toe** (*adductor pollicis pedis*), situated upon the outer side of the short flexor, belongs properly to the interosseous group. It arises from the calcaneo-cuboid ligament, the sheath of the long peroneal tendon, and bases of the second and third metatarsal bones, proceeds forward, and is inserted in common with the outer tendon of the short flexor.

Use.—To draw the great toe toward the others.

The **Transverse Muscle of the Foot** is a collection of fleshy fibres, that cross the under surface of the anterior extremities of the metatarsal bones, extending successively from the fifth to the first.

Use.—To approximate the heads of the metatarsal bones.

The **Short Flexor Muscle of the Small Toe** (*flexor brevis minimi digiti*) arises from the cuboid and fifth metatarsal bones, and is inserted into the base of the first phalanx of the small toe.

Dissection.—Remove the preceding muscles, and the tendon of the long peroneal muscle will be seen crossing the bottom of the foot obliquely forward and inward, from the groove in the cuboid bone, to be inserted into the internal cuneiform and the base of the first metatarsal bone. The interosseous muscles will be also brought into view.

The **Interosseous Muscles,** eight in number, including the adductor of the great toe, fill up the spaces between the metatarsal bones. They arise from the respective borders of the bones between which they are placed, and are inserted into the bases of the first phalanges of the toes. All the toes are provided with two of these muscles (one on each side), except the great and the small toe, which have each a separate abductor placed along the corresponding borders of the foot.

Use.—They are all either adductors or abductors of the toes, taking the middle line of the foot as the point of departure.

VESSELS AND NERVES OF THE LOWER EXTREMITY.

The student, having reserved one of the lower limbs for the study of the vessels and nerves, should now proceed to expose the main trunks of the superficial veins which lie between the skin and the aponeurosis. In connection with these, the parts concerned in femoral hernia should be particularly examined.

Some of the vessels and nerves of the lower extremities have already been casually referred to, in the descriptions of the femoral and crural regions, but are here considered in detail. Those situated in the posterior pelvic region have been appropriately described in connection with the muscles of that portion of the inferior extremity (p. 359), and therefore need not be again alluded to. In like manner, the great sciatic

nerve has been fully described in its relations to the posterior femoral region (p. 366).

The Superficial Veins are the Long and Short Saphena.

The **Long** or **Internal Saphena Vein** (Fig. 171) commences by a number of branches upon the dorsal surface of the inner border of the foot, near the root of the great toe, runs backward toward the ankle, where it makes a turn in front of the internal malleolus, ascends along the inner side of the leg, behind the internal tuberosity of the tibia and corresponding condyle of the femur, continues upward upon the inner side of the thigh, and, having reached within about an inch of the crural arch, turns suddenly through the saphenous opening in the femoral aponeurosis, and terminates in the femoral vein. In its course it receives a great number of collateral branches, and consequently increases gradually in size from below upward. It moreover receives communicating branches from the deep veins, and not unfrequently consists of two main trunks, nearly parallel, communicating with each other by transverse branches, and uniting just at the saphenous opening. Near its termination in the femoral, the long saphena vein receives the superficial epigastric, external pudic, and superficial circumflex iliac veins. The number of its valves varies from two to four or six, most of them below the knee. From the knee to the ankle the vein is accompanied by the long saphenous nerve, which leaves the femoral artery and vein, and perforates the fascia near the inner condyle of the femur.

The **External** or **Short Saphena Vein** (Fig. 172), situated upon the outer back part of the leg, commences on the dorsal surface of the outer border of the foot, passes behind the external malleolus, then turns directly upward, runs along the outer border of Achilles' tendon, gains the middle of the calf of the leg, and ascends in this situation to the lower division of the popliteal space, where it perforates the fascia, and terminates in the popliteal vein. It receives a great number of collateral branches in its course, and before reaching its termination attains a considerable size. It has but two valves, one just at its termination and the other some distance below, and hence one reason for its great liability to become varicose. Between the ankle and the knee, it is superficial to the external saphenous nerve, being separated from it by the crural fascia.

The Superficial **Nerves** encountered in the removal of the skin from the lower extremity are very numerous but small. They are nearly all derived originally from the lumbar and sacral plexuses, and are either branches of the crural and sciatic nerves, or of the plexuses themselves. They perforate the femoral and crural aponeurosis at various points, descend to a greater or less distance in the subcutaneous areolar tissue, and

are for the most part ultimately distributed to the skin. The only one of any particular practical importance is the *long saphenous*, which perforates the femoral aponeurosis beneath the inner condyle of the femur, and accompanies the long saphena vein to the foot. It is liable to be wounded in operations upon the vein below the knee.

Fig. 171.

Long saphena vein. 1, superficial epigastric vein; 2, internal pudic vein; 3, superficial circumflex vein; 4, origin of long saphena; 5, its termination in femoral vein.

Fig. 172.

Superficial veins of back of leg. 1, short saphena vein; 2, position at which it terminates in popliteal vein; 3, long saphena vein.

For convenience and uniformity of description, the remaining vessels and nerves of this extremity may now be examined, although the Anatomy of Femoral Hernia, next to be considered, would naturally claim precedence

on account of its more intimate association with the superficial structures just mentioned (see page 389).

Dissection.—Divide the femoral aponeurosis by a vertical incision extending from the middle of Poupart's ligament to the patella, and turn it to either side. Remove the areolar tissue from around the vessels and nerves and the intermuscular septa, retaining the muscles as nearly as possible in their natural position.

The **Femoral Artery** is the continuation of the external iliac, and makes its appearance in the thigh, beneath the crural arch, midway between the anterior superior spinous process of the ilium and the symphysis of the pubis, having the femoral vein upon its inner and the crural nerve upon its outer side. From this point it descends almost vertically, but gradually getting deeper, through the middle of Scarpa's triangle, in this space resting first upon the inner border of the psoas, next the outer border of the pectineus, and then upon the short adductor, which separate it from the head of the femur. This course it follows until it reaches the junction of the middle with the upper third of the thigh, at which point, together with its accompanying vein and saphenous nerve, the artery enters the canal formed by the insertion of the long adductor, the inner border of the internal vastus, and the middle section of the sartorial, lying here in close apposition with the inner surface of the femur. Traversing this canal, it reaches the upper angle of the popliteal space, the vessel here taking the name of the Popliteal Artery. The course of the femoral is generally stated to be indicated by a line drawn from a point midway between the anterior superior spine of the ilium and the symphysis of the pubes to the inner side of the patella; but an additional guide to its anatomical relations is found, in its more superficial portions, in the depression between the adductors of the inner side of the thigh and the muscles on the outer side.

The femoral artery may be considered, therefore, as divided into two parts, the first corresponding to the upper third of the thigh bone and situated in the femoral triangle, and the second corresponding to the middle third of the bone and contained within the canal (Hunter's canal) formed by the three muscles above mentioned. The *femoral triangle* (Scarpa's triangle), situated upon the upper anterior part of the thigh, is bounded externally by the upper third of the sartorial muscle, internally by the long adductor, and above by the crural arch. It is covered in front by the femoral aponeurosis, and contains the first division of the femoral artery and its branches, the femoral vein, and the lash of nerves formed by the division of the crural nerve.

Branches.—The femoral artery gives off a number of branches, namely, the external pudics, superficial epigastric, superficial circumflex iliac, deep femoral, and anastomotic arteries, besides several small twigs to the adjacent muscles, fascia, and skin. By far the most important of these is the deep femoral.

The **External Pudic Arteries,** very small, two in number, and called from their relative position the superior and inferior, arise from the inner side of the femoral artery, just below the pubis, pass inward and upward, perforate the femoral aponeurosis, and are distributed to the skin of the lower part of the abdomen and external organs of generation.

Fig. 173.

Diagram of Scarpa's triangle. 1, sartorial; 2, long adductor; 3, external cutaneous nerve; 4, internal iliac muscle; 5, crural nerve; 6, femoral artery; 7, femoral vein; 8, pectineus; 9, long saphenous nerve; 10, internal cutaneous nerve; 11, nerve to internal vastus; 12, middle cutaneous nerve.

The **Superficial Epigastric Artery,** also very small, arises from the front of the femoral artery, about half an inch below the crural arch, passes through the saphenous opening in the femoral aponeurosis, and is distributed to the skin of the lower part of the anterior abdominal wall.

The **Superficial Circumflex Iliac Artery,** no larger than the preceding, near which it arises, passes outward, giving twigs to the subjacent muscles, perforates the aponeurosis near the anterior superior iliac spine, and is spent upon the integument.

The **Deep Femoral Artery** (*profunda femoris*) is nearly as large as the main trunk of the femoral, from the outer back part of which it arises, about an inch and a half below the crural arch, descending at first a little outward and then backward upon the iliac and pectineus muscles, passing behind the long adductor, resting upon the small and great adductors, and dividing into three or four terminal branches, which perforate the great adductor muscle near its insertion into the upper part of the rough line, and are distributed to the muscles of the thigh.

The deep femoral sometimes originates less than an inch and a half below the crural arch, a circumstance that adds to the difficulty and insecurity of placing a ligature upon the common femoral immediately below the arch. Very rarely it is given off more than two inches below.

Branches.—The principal branches of the deep femoral are the external and internal circumflex, and perforating arteries.

The *External Circumflex,* quite large, arises from the outer aspect

of the deep femoral, and sometimes from the common femoral, passes outward beneath the sartorial and middle head of the triceps muscle, the divisions of the crural nerve passing behind and in front of it, and divides into a great number of branches, which are distributed particularly to the muscles upon the outer side of the hip and thigh, anastomosing above with the branches of the gluteal and circumflex iliac arteries, and below with the articular branches of the femoral and popliteal.

The *Internal Circumflex*, smaller than the preceding, arises from the inner side of the deep femoral, runs inward and backward beneath the pectineus muscle, and is distributed to the muscles in this situation. It sends a small articular branch through the notch of the acetabulum to the adipose tissue within the hip joint and to the round ligament and head of the femur.

The *Perforating Arteries*, three or four in number, and quite large, are the terminal divisions of the deep femoral, perforate the great and small adductor muscles near their insertion, and are distributed to the muscles upon the back of the thigh.

The **Anastomotic Artery** is small, but constant in its occurrence. It arises from the femoral immediately above the opening in the great adductor muscles, descends toward the inner condyle of the femur in company with the long saphenous nerve, and is distributed to the parts about the knee joint, anastomosing with the articular branches of the popliteal artery.

The **Femoral Vein** lies upon the inner side of the artery beneath the crural arch, but traced from this point downward it will be found to get gradually behind it, and in the middle third of the thigh lies nearly upon its outer side. The two are inclosed in the same sheath, and are joined about the middle of the triangle by the long saphenous nerve, a branch of the crural, which enters the sheath and descends along with the vessels to the point where they pass through the opening in the great adductor muscle; here it leaves them, and, passing beneath the sartorial muscle, perforates the femoral aponeurosis upon the inner side of the knee, and joins the long saphena vein.

The *Deep Femoral Vein* accompanies the artery of the same name, and opens into the femoral vein from behind, about two inches below the crural arch.

Surgical Considerations.—The femoral artery may be most conveniently compressed for the purpose of controlling its circulation either upon the body of the pubis or in the lower part of the femoral triangle. In the former situation the vessel is almost superficial, and, lying directly upon the bone, is on these accounts very favorably situated for this purpose; but owing to the almost impossibility of adjusting a tourniquet to the limb so near the pelvis, or of conveniently grasping it with the hand when this is the compressing agent, this is not the point generally chosen, except in high amputations of the thigh, where either

the tourniquet or the fingers, if applied lower down, would be in the way. The point usually selected for this purpose, in operations upon the limb below the middle third of the thigh, is the lower part of the femoral triangle, where the tourniquet may be conveniently applied and the artery compressed against the femur.

Ligation of the femoral artery may be practiced in any part of its length, but where the vessel is nearest the surface it is, of course, most accessible, and, as a general rule, the safest for the patient. Hence, the proper situation is the femoral triangle, for here the vessel is covered only by the integument, superficial fascia, and femoral aponeurosis. But all parts of the artery within the triangle are not equally favorable; thus, immediately below the crural arch it may be reached with but little difficulty, but a strong objection to applying a ligature here is the nearness of the origins of the epigastric artery, given off from the external iliac, and the deep femoral artery, it being a fact well ascertained that where a ligature is applied very near to a large collateral branch, and more especially between two, the danger of secondary hemorrhage arising from an imperfect obliteration of the vessel is much increased. The most advantageous point, therefore, is the lower angle of the femoral triangle, taking the inner margin of the sartorial muscle as the guide. Here no large collateral branch interferes (except in those very rare cases in which the deep femoral has a very low origin), and the vessel may be exposed without much difficulty. Care should be taken not to include the long saphenous nerve in the ligature.

The **Crural Nerve**, also seen in this dissection, is the external terminal branch of the lumbar plexus (see page 263). It leaves the abdominal cavity beneath the crural arch, externally to the psoas, and upon the surface of the iliac muscle; having passed the arch, it turns a little outward, becomes somewhat flattened, and almost immediately divides into a lash of diverging branches, which are distributed principally to the rectus and triceps muscles upon the front of the thigh. One branch, called the *internal* or *long saphenous nerve*, gains the outer side of the femoral vessels which it accompanies, being inclosed in the same fibrous sheath, as far as the opening in the great adductor muscle; there leaving the vessels, it passes over the back of the internal condyle of the femur beneath the tendon of the sartorial muscle, and perforating the femoral fascia reaches the long saphena vein, which it accompanies to the foot. In its course, the long saphenous nerve gives off numerous filaments, most of which are distributed to the skin of the inner surface of the thigh, knee, leg, and foot.

The *Popliteal Space* or pit of the ham is the large diamond-shaped interval, situated upon the back part of the lower extremity of the femur and the knee. It is formed principally by the divergence of the biceps or external hamstring muscle on one side, and the semitendinous and semimembranous or internal hamstring muscles on the other, and is, therefore, situated mostly above the knee joint; its inferior short angle is formed by the two heads of the gastrocnemius muscle, which arise from the corresponding condyles of the femur internal to the hamstring muscles, and unite about an inch below the joint. The space is covered in by the skin and a continuation of the femoral aponeurosis, and contains an abundance

of cellular adipose tissue, the popliteal artery and vein, the popliteal and peroneal nerves, and three or four lymphatic glands. The nerves are superficial and external to the vessels; the artery, which is the continuation of the femoral, lies close to the bone nearly in the middle line, but inclines from above downward and a little outward; the vein is less deep seated than the artery, along the outer border of which it is placed, and to which it is very closely adherent.

The **Popliteal Artery**, the continuation of the femoral, enters the popliteal space at its upper angle, descends along the median line in close contact with the femur and overlapped slightly by the semimembranous muscle, crosses the posterior surface of the knee joint and the popliteal muscle, and disappears in the angle formed by the convergence of the two heads of the gastrocnemius muscle, beneath which it is continued to form the posterior tibial artery. Its relations to the popliteal vein and nerve are important (Fig. 174). The vein lies a little superficial to the artery and along its outer border, and the two are so intimately connected by close areolar tissue as to render their separation oftentimes quite difficult. The popliteal nerve is external to the vein and more superficial, and the peroneal nerve is still farther removed toward the outer border of the space.

Fig. 174.

Popliteal space. 1, biceps; 2, peroneal nerve; 3, plantaris; 4, outer head of gastrocnemius; 5, semitendinous; 6, semimembranous; 7, gracilis; 8, sartorial; 9, inner head of gastrocnemius.

The popliteal artery sends small twigs to the hamstring muscles on each side, several considerable branches (*sural arteries*) to the heads of the gastrocnemius muscle, and five small branches to the knee joint. Of the articular branches two are superior, two inferior, and one middle. The *superior articular* are given off behind the condyles of the femur, encircle the lower extremity of this bone, and divide into numerous branches for the supply of the ligamentous and osseous structures about the joint. The *inferior articular* surround the head of the tibia and fibula, and likewise break up into a large number of small branches, which anastomose freely with the preceding, and supply the same structures about the lower part of the knee. The *middle* or *azygos articular* arises between

the superior and inferior, enters the joint through the posterior ligament, and is distributed to the synovial membrane and adipose tissue within the cavity.

Having reached the lower border of the popliteus muscle, the popliteal artery divides into the anterior and posterior tibial arteries.

The **Popliteal Vein** (Fig. 174) is formed by the junction of the anterior and posterior tibial veins in the lowest part of the popliteal space; the anterior tibial vein being a continuation of the dorsal veins of the foot, and the posterior tibial being formed by the union of the external and internal plantar veins. It ascends in the same sheath with and upon the posterior and outer side of the popliteal artery, receives a number of small veins in its course, and becomes continuous above with the femoral vein.

The **Popliteal Nerve** (Fig. 174) is the continuation of the main trunk of the great sciatic (see p. 367). It enters the popliteal space from above, where it joins the popliteal artery and vein, and descends upon their outer and posterior aspect to the lower extremity of the space, and here, passing beneath the gastrocnemius and soleus muscles, it takes the name of the posterior tibial nerve.

The **Posterior Tibial Nerve** descends the leg with the posterior tibial vessels, which it accompanies to the sole of the foot, where it divides into the *external* and *internal plantar nerves*, and is finally distributed to the muscles of the sole and to the skin of the five toes. In its course it gives off a great number of branches to the knee joint, and to the muscles and skin of the leg and foot. One of the principal of these branches is the *external saphenous nerve* (communicans tibiæ), which arises in the lower part of the popliteal space, passes down the middle line of the posterior surface of the gastrocnemius muscle, perforates the fascia to gain the side of the short saphena vein, runs along the outer margin of the Achilles' tendon, turns around the external malleolus, and is distributed to the skin upon the outer border of the heel and foot, some of its filaments extending as far as the small toe.

The **Peroneal** or **Fibular Nerve** usually leaves the great sciatic at its entrance into the popliteal space, but not unfrequently the division occurs much higher,—sometimes, indeed, within the cavity of the pelvis. It passes downward and outward through the popliteal space behind the external condyle of the femur, crosses obliquely over the external head of the gastrocnemius muscle and head of the fibula, beneath the origin of the long peroneal muscle, turns horizontally forward, and divides into its two terminal branches. The *external peroneal* or *musculo-cutaneous branch* passes downward through the muscles upon the fibula, to which it gives filaments, perforates the fascia a short distance above the ankle, follows

the direction of the long extensor muscle of the toes, and is distributed to the skin upon the upper surface of the foot and roots of the toes. The *anterior tibial nerve*, the larger of the two, passes beneath the origin of the long extensor muscle of the toes to reach the outer side of the anterior tibial artery, which it accompanies to the dorsal surface of the foot, and is there distributed to the skin near the inner border of the foot as far forward as the great toe.

The peroneal nerve, while in the popliteal space, sends off the *short saphenous nerve.* This descends upon the posterior surface of the gastrocnemius muscle, and perforates the fascia about the middle of the leg to join the short saphena vein, which it accompanies along the outer border of Achilles' tendon, and is distributed to the skin upon the outer surface of the heel.

The **Posterior Tibial Artery**, the proper continuation of the popliteal, descends between the superficial and the deep layer of muscles on the back of the leg, and passes through the space between the internal malleolar process of the ankle and the heel, to reach the sole of the foot, where it divides into the internal and external plantar arteries. It is placed, at first, in the middle line of the leg, covered by the deep fascia and the gastrocnemius and soleus muscles, but gradually inclines inward as it descends, and at the ankle lies behind the internal malleolus, between the tendons of the long flexor of the toes and the long flexor of the great toe, covered by only the skin and internal annular ligament. It is accompanied by two veins, one on each side, and by the posterior tibial nerve, which is at first upon the inner side of the vessel, but soon crosses to the outer side and maintains this position in the rest of its course.

With the exception of one considerable branch, the peroneal, the posterior tibial sends off only small twigs to the adjacent muscles and tibia.

The **Peroneal Artery** arises from the posterior tibial just below the margin of the popliteal muscle, passes at first downward and outward to reach the fibula, close beneath the inner border of which it descends, lying upon the interosseous membrane, to the outer side of the calcaneum, where it divides into a number of small branches. In its course, it gives off numerous twigs to the muscles and bone, and, about two inches above the external malleolus, sends off a branch called the *anterior peroneal*, which perforates the interosseous membrane, and descends upon the front of the fibula to the outer side of the ankle and foot.

The **Internal** and **External Plantar Arteries** are the terminal divisions of the posterior tibial artery, this vessel bifurcating upon the inner back part of the sole of the foot, beneath the commencement of the abductor muscle of the great toe. The *external*, much the larger of the two, passes outward and forward between the short flexor of the toes and the

accessory muscle, to reach the fifth metatarsal bone, upon the tarsal extremity of which it turns toward the inner border of the foot; it traverses the under surface of the fourth, third, and second metatarsal bones to join the dorsal artery of the foot in the space between the first and second of these bones, forming thus an arch (plantar arch), from which branches are given to the several adjacent muscles, and to the four smaller toes. The *internal*, much smaller, passes forward near the inner border of the foot, supplies twigs to the abductor and short flexor muscles of the great toe, and finally expends itself upon the inner side of this toe.

The *Internal Plantar* and *External Plantar Nerves* accompany the corresponding arteries to the inner and outer side of the foot, respectively.

The **Anterior Tibial Artery**, the anterior of the two terminal branches of the popliteal, passes at first forward between the heads of the posterior tibial muscle, and then through the interval in the upper extremity of the space between the tibia and fibula, where the interosseous membrane is deficient, to reach the anterior surface of the leg. It then descends upon the anterior surface of the interosseous membrane to the ankle, lying at first between the anterior tibial muscle and the long extensor of the toes, and lower down between the former of these two muscles and the extensor of the great toe. In the upper part of the leg it is deeply seated, but becomes gradually more superficial as it descends, and just above the ankle it gets upon the anterior surface of the tibia, passes beneath the anterior annular ligament, and is crossed from without inward by the tendon of the extensor of the great toe, continuing its course forward as the *dorsal artery of the foot*. It is accompanied by two veins, one on each side, and also by the anterior tibial nerve, the continuation of the main trunk of the peroneal, which, having crossed the head of the fibula, enters the interosseous space to the outer side of the vessels, but gradually gets in front of them as it descends.

The branches of the anterior tibial artery are numerous and small, and distributed principally to the adjacent muscles. It sends off, also, just below the head of the tibia, a small *recurrent artery*, which ascends through the head of the anterior tibial muscle, to the front of the knee joint; and, near the ankle, an *internal* and an *external malleolar* branch, which are distributed to the corresponding surfaces of the joint.

The **Dorsal Artery of the Foot**, the continuation of the anterior tibial, runs forward over the tarsal bones along the outer border of the tendon of the extensor muscle of the great toe, and, having reached the space between the first and second metatarsal bones, passes through to join the plantar arch. Near its termination it sends a small branch to the muscles occupying the first interosseous space.

Lymphatics.—The *Lymphatic Glands* of the lower extremity are—1,

the *anterior tibial*, a single gland, often wanting, situated in the upper part of the space between the tibia and fibula, upon the anterior surface of the interosseous membrane; 2, the *popliteal*, four in number, situated in the popliteal space, one of them superficial, and the others along the course of the popliteal vessels; and 3, the *inguinal*, superficial and deep. The superficial inguinal glands are situated in the depression upon the femoral aponeurosis, around the saphenous opening; they vary from three or four to as many as eight or ten in number, and differ very materially in size in different individuals. The deep glands are often wanting, but, when present, are found around the femoral vessels between the saphenous opening and the cavity of the pelvis. Their number is not constant, but rarely exceeds three or four; one is generally found occupying the internal femoral ring. The inguinal glands also receive the lymphatic vessels of the external organs of generation, perineum, lower part of the abdominal walls, and integuments of the outer side of the pelvis.

The *Lymphatic Vessels* of the lower extremity are superficial and deep. The *superficial lymphatics* are situated between the skin and femoral aponeurosis, and are arranged into two sets, the one accompanying the short saphena vein to terminate in the popliteal glands, and the other the long saphena vein to the inguinal group. The *deep lymphatics* accompany the large bloodvessels; a few upon the anterior part of the leg pass through the anterior tibial gland, the others enter the popliteal and inguinal groups, and all eventually form a chain of lymphatics along the external iliac artery, terminating in the lumbar glands. To reach this chain, the efferent vessels from the superficial inguinal glands perforate the femoral aponeurosis over the femoral canal, and pass beneath the crural arch.

ANATOMY OF FEMORAL HERNIA.

The canal or passage through which Femoral Hernia occurs, extends from beneath the internal extremity of the crural arch (Poupart's ligament) to the opening in the femoral aponeurosis through which the saphena vein communicates with the femoral; it is about an inch in length. The parts may be studied either from within or without; but if the pelvis has been divided, and a separate extremity reserved for this purpose and for the study of the vessels and nerves, it is best to commence within, and trace the canal to its external termination or outlet. Sponge the blood and other dirt from the soft parts situated upon the internal surface of the innominate bone, and from the adjacent surface of the anterior wall of the abdomen; and, if the peritoneum has been removed, it will be observed, in the first place, that the crural arch, which, it will be remembered, is only the lower edge of the tendon of the external oblique

muscle, stretches from the anterior superior spine of the ilium to the spine of the pubis, and that in the latter situation it expands a little outward to form a small triangular process, called Gimbernat's ligament, which occupies the angle between the internal extremity of the arch and the bone; it is attached, to the distance of half an inch or more, along the ilio-pectineal ridge or line, and presents a free lunated border outward and a little backward.

The large triangular space between the arch, the anterior margin of the ilium, and the body of the pubis, is occupied by the psoas and iliac muscles, the crural nerve, and the external iliac artery and vein (Fig. 175). The nerve is external to the psoas and upon the surface of the iliac muscle. The artery crosses the body of the pubis, internal to the two muscles, the vein being upon the inner side of the artery. A closer examination will discover a quadrangular interval between the vein and the free margin of Gimbernat's ligament. It is bounded above by the crural arch, and below by the body of the pubis, and varies from half an inch to an inch in breadth either way, but is generally larger in females than in males, on account of the somewhat greater breadth of the pelvis. This is the *Internal Femoral Ring* (Fig. 176), the entrance to the femoral canal. It is occupied usually by a single lymphatic gland, and a small quantity of areolar tissue (called by Cloquet the *septum crurale*), and covered in above by the parietal layer of the peritoneum.

Fig. 175.

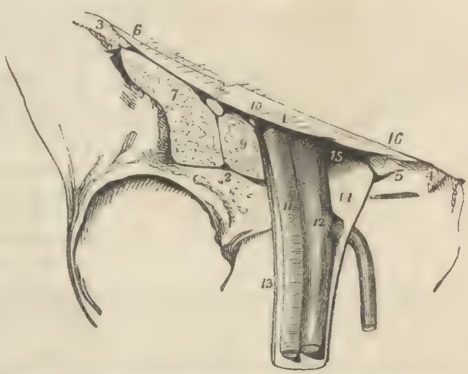
Portion of anterior wall of abdomen and pelvis, seen from behind, innominate bone of left side with soft parts connected with it having been removed. 1, pubic symphysis; 1′, body of pubis; 2, irregular surface of ilium, separated from sacrum; 3, spine of ischium; 4, tuberosity of ischium; 5, internal obturator muscle; 6, straight (rectus) muscle of abdomen covered behind by thin expansion from (7) transverse fascia; 8, iliac fascia covering iliac muscle; 9, great psoas muscle cut; 10, external iliac artery; 11, external iliac vein; 12, epigastric artery and two accompanying veins; 13, vessels of spermatic cord entering internal abdominal ring; in this case ring was unusually small; 14, two obturator veins; 15, fibrous remains of umbilical artery; opening upon right side of external iliac vein is internal femoral ring.

The disposition of the fasciæ of the abdomen, in reference to this opening, is a matter of some interest. Thus the transverse fascia (which lines the posterior surface of the transverse muscle in the inguinal region) and the iliac fascia (covering the surface of the psoas and iliac muscles, and continuous at the brim of the pelvis with the fascia lining this cavity)

meet at the crural arch, and become attached to this structure in the outer two-thirds or three-fourths of its extent, strengthening the abdominal walls at this point. But internally to the psoas muscle, the external iliac artery and vein resting upon the surface of the iliac fascia, the latter, instead of being connected to the arch in this situation, is continued out behind or beneath the vessels, and over the body of the pubis. The transverse fascia, also attached to the arch in the outer two-thirds of its extent, here passes out in the same manner as the preceding, but in front of or above the vessels. This continuation of the iliac fascia below, and the transverse fascia above, constitutes the sheath of the vessels, and, as the two membranes occupy in their descent the whole of the space between the inner border of the psoas muscle and the crescentic margin of Gimbernat's ligament, the entrance or mouth of the sheath is large and funnel-shaped, and embraces not only the bloodvessels, but the space between the vein and the free border of the ligament.

The femoral ring comprises, therefore, the internal half or third of the mouth of the sheath; but as this structure descends it narrows, and at the saphenous opening embraces the vessels closely, and is here continuous with the femoral aponeurosis. It will be understood, then, that the femoral canal is funnel-shaped; that it is nothing more than the unoccupied portion of the sheath of the femoral vessels lying internally to the vein; and that it extends from the internal femoral ring (by which it communicates with the cavity of the abdomen external to the peritoneum) to the saphenous opening in the femoral aponeurosis, the distance between the two being about an inch. The shape of the internal femoral ring is, as above stated, quadrangular, and its boundaries are the following unyielding structures: the crural arch *above*, the body of the pubis *below*, the femoral vein *externally*, and the crescentic margin of Gimbernat's liga-

Fig. 176.



Femoral or crural arch, and structures situated between it and anterior part of superior margin of pelvis. 1, crural arch or Poupart's ligament; 2, pubic bone; 3, anterior superior spine of ilium; 4, spine of pubis; 5, pectineal line, and insertion of Gimbernat's ligament; 6, sartorial; 7, iliac muscle cut; 8, crural nerve cut; 9, great psoas muscle cut; 10, point at which crural branch of genito-crural nerve reaches thigh; 11, femoral artery; 12, femoral vein, receiving saphena vein; 13, external portion of sheath of femoral vessels lying in contact with femoral artery; 14, large funnel-shaped cavity of sheath to inner side of femoral vein; 15, internal femoral ring, bounded above by crural arch, behind by pubis, externally by vein, and internally by free edge of (16) Gimbernat's ligament.

ment *internally.* But its relations must not be neglected. The epigastric artery is but a little way removed from its outer border; the obturator artery, generally a branch of the internal iliac artery, frequently arises from the femoral in common with the epigastric; in this case, in order to reach the obturator foramen, through which it almost invariably emerges from the pelvis, it either descends immediately along the outer boundary of the ring, or else travels along its superior boundary, and turns down behind the crescentic border of Gimbernat's ligament, thus encircling the upper half of the opening. This anomalous distribution of the obturator is said, by most writers, to be rare, but, according to the author's observations, it occurs sufficiently often to make it a matter of serious consideration, in all cases where an operation is demanded.

The student should now make an examination of the Saphenous Opening or External Femoral Ring, which may be dissected in the following manner:

Dissection.—Divide the skin by an incision extending from the anterior superior iliac spine vertically downward to the distance of eight or ten inches, and from its lower extremity extend another transversely inward to the inner border of the thigh; dissect up the flap, and turn it inward; next, raise the subcutaneous adipose tissue, which is often abundant, and the superficial fascia, in one layer, from the femoral aponeurosis in the same manner. When this is done, the femoral aponeurosis thus brought into view, will be seen to present just below the internal extremity of the crural arch, a considerable depression, occupied by areolar tissue, lymphatic glands, one or more small arteries and numerous small veins, and the main trunk of the internal saphena. Dissect out the areolar tissue and lymphatic glands close to the aponeurosis, commencing at the outer side of the depression, and cut off all the vessels except the large vein, and the external femoral ring will be brought into view (Fig. 177).

Fig. 177.

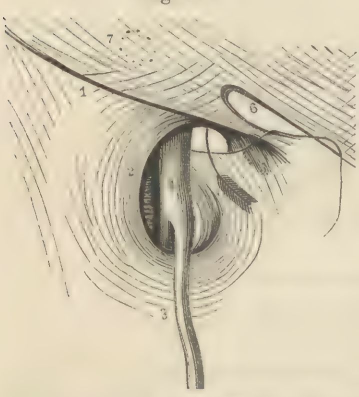


Diagram of femoral ring. (The arrow is introduced into the ring.) 1, crural arch; 2, saphenous opening of fascia lata; 3, saphena vein; 4, femoral vein; 5, Gimbernat's ligament; 6, external ring; 7, position of internal ring.

The subcutaneous areolar tissue or *superficial fascia* found in this region varies in its thickness according to the amount of adipose tissue it contains, and can always be split by careful dissection into a number of layers. It is loose and open in the depression occupied by the saphena vein, but at the bottom of this excavation forms a more condensed layer, which is closely attached to the margin of the saphenous opening, and being perforated by numerous small arteries and veins is called the *cribriform fascia.*

The *Saphenous Opening* (external femoral ring) is situated in the femoral aponeurosis upon the upper anterior part of the thigh, about two inches externally to the pubic symphysis, and less than an inch below the inner third of the femoral arch. It is oval in shape from above downward, and is occupied by the saphena vein, the cribriform fascia, and the small vessels which perforate the latter. It is not an abrupt hole in the femoral aponeurosis, but is somewhat valvular, in consequence of the projection or overlapping of its external border. Its margins give attachment, as just mentioned, to the cribriform fascia, upon the removal of which they present the clean cut appearance represented in the accompanying plate (Fig. 177). The *lower margin*, it will be observed, is sharp and lunated, and crosses the front of the femoral vein immediately below the termination of the saphena. The *internal margin* is considerably depressed below the others, and may be traced behind the femoral vessels, to the sheath of which it is closely attached. The *external margin*, much thicker and stronger than the others, is situated upon a plane considerably above or anterior to the preceding, and extends, in the form of a crescent, from the outer extremity of the lower edge to the internal extremity of the femoral or crural arch, with which it is continuous. From its curved direction and its dense fibrous structure it is called the *falciform ligament*, and as it projects over the opening it constitutes the principal protection against the occurrence of hernia, and also an obstacle to its reduction in this situation. In the extended position of the thigh it is firm and tense, but may be somewhat relaxed by flexing the limb, rotating it inward, and carrying it to the opposite side. The *upper margin* of the opening is formed by the continuation of the falciform ligament with the femoral arch, and is sometimes denominated *Hey's ligament.*

The *Femoral Canal* extends between the two openings just described, and is therefore quite short, measuring not more than a half or three-fourths of an inch in length along its anterior wall. It is surrounded on three sides by firm fibrous tissue, the femoral vein forming its outer boundary, and is lined throughout by the funnel-shaped portion of the sheath of the vessels. Its most important relation, in a surgical point of view, is that with the obturator artery when this vessel is a branch of the epigastric.

THE HEAD AND NECK.

THE Head consists of the cranium and face, the former containing the brain and its appendages, and the latter the organs of the senses and other important parts. The Neck includes various structures connected with important physiological functions, such as respiration, deglutition, etc., in addition to numerous nervous and vascular bonds of communication between the head and trunk.

It is almost impossible to isolate parts so intimately associated in their anatomical distribution for separate description, and it is therefore deemed expedient to describe the head and neck to a certain extent conjointly; in the order, however, in which the parts are revealed by dissection, and therefore as appropriately belonging to each region.

The superior part or top of the cranium should be dissected first.

SUPERIOR PORTION OF THE CRANIUM.

Upon each side of the median line of the cranium, and immediately beneath the skin, is a thin membranous muscle called the Occipito-frontal, extending, as its name signifies, from the occiput to the forehead.

Dissection.—Divide the skin by a horizontal incision leading from the middle of the forehead to the occipital protuberance, and connect its two extremities by carrying the knife in the middle line over the top of the head. Commencing in front, remove the included flap of skin together with the subcutaneous areolar tissue. Much care is required in making this dissection to avoid cutting up the broad tendon or aponeurosis of the muscle along with the skin. Dissect the opposite side in the same manner.

The **Occipito-frontal Muscle** consists of an anterior and a posterior thin, pale, fleshy belly, and an intervening broad aponeurosis, which covers the top of the cranium. The *posterior belly* is attached by tendinous and fleshy fibres to the external two-thirds of the superior curved ridge of the occiput and the adjacent part of the mastoid process, from which points the fibres ascend forward and inward to the distance of an inch or more, and end in the broad aponeurotic tendon. The *anterior belly*, somewhat thicker but paler than the posterior, descends from the anterior edge of the tendon, to be inserted, for the most part, into the integument of the eyebrow. A small fleshy slip is continued down from its internal border to the side of the nose, under the name of the pyramidal nasal muscle.

The occipito-frontal muscle is separated from the cranium by loose areolar tissue, and from the superjacent skin by a condensed layer of areolar adipose tissue. Its external margin slightly overlaps the temporal aponeurosis that covers in the temporal muscle; the internal is connected to the opposite muscle by a thin tendinous expansion. Its anterior extremity is blended with the orbicular muscle of the eye.

Use.—To fix the skin of the head, elevate the eyebrows, and assist in raising the upper eyelid.

Dissection for removal of the Brain.—Having dissected off the occipito-frontal muscle, saw the skull upon a level with the tops of the ears, commencing the incision in front about an inch above the superior margins of the orbits, and terminating it behind, half an inch above the occipital protuberance. In doing this, it will become necessary to cut through the upper part of the temporal aponeurosis and muscle on each side. After the bones have been sawn completely through at all points, pry off the calvarium by means of a chisel. This being done, the external surface of the dura mater, studded with vascular points and minute fibrous processes by which it is attached to the inner surface of the bones, will be exposed to view; but as this membrane cannot be entirely examined until the brain is removed, it should be divided upon a level with the sawn edge of the skull for two-thirds of the distance around, leaving an uncut portion in the middle line behind. In the median line in front, the scissors should be introduced to the depth of half an inch or more between the hemispheres of the brain, to divide the anterior extremity of the falciform process. The dura mater having been divided and turned back, the convoluted surface of the two cerebral hemispheres, separated from each other by an antero-posterior fissure, and covered by the pia mater and arachnoid membranes, will be brought into view.

The next step in the dissection is to remove the brain with the origins of the nerves, leaving the dura mater in the skull. For this purpose, gently elevate the anterior extremities of the hemispheres, and the two large bulbous nerves, constituting the first or olfactory pair, will be perceived lying upon the cribriform plate of the ethmoid bone, separated from each other by the crest; they may be detached from their situation by passing the handle of the scalpel underneath them. Raise the brain a little higher, and the two optic nerves, recognized by their large size and clear white color, may be seen leaving the cranium through the optic foramina in the sphenoid bone; divide them close to the bone, and also the two internal carotid arteries that lie immediately behind. Between the latter, and occupying the pituitary fossa of the sphenoid bone, is a transversely oval body called the pituitary body; it is attached to the base of the brain by a delicate pedicle called the infundibuliform process, and must be raised with the handle of the scalpel.

Behind the optic nerves is the third pair, which leave the cranium through the sphenoidal fissure. These can be more conveniently divided with the scissors. Next, elevate the brain gently on each side, and, passing the edge of the scalpel along the superior border of the petrous portion of the temporal bone, divide the tentorium or transverse process of the dura mater, which stretches forward from the transverse ridge upon the occipital bone, for the purpose of supporting the posterior lobes of the cerebrum. Immediately beneath the anterior margin of the tentorium is the fourth nerve or patheticus (often somewhat difficult to distinguish on account of its exceedingly small size), also on its way to the sphenoidal fissure. Directly behind the fourth, the fifth pair, the largest of the cerebral nerves, may be perceived passing forward to form a large ganglion (ganglion of Gasser), which rests upon the inner extremity of the petrous bone.

The main trunk of the fifth having been divided, taking care not to tear the nerve from its origin, the sixth pair will be discovered some little distance behind and nearer the median line, diverging slightly from each other toward the sphenoidal fissure. Continuing to elevate the brain, the seventh and eighth will be seen entering together the internal auditory foramen, close to which they should

be divided. The ninth, tenth, and eleventh, composing what was formerly called the eighth pair, converge behind toward the jugular foramen, and should next be severed. Finally, the twelfth, the last of the cranial nerves, will be found immediately in front of the preceding, entering the posterior condyloid foramen. These last having been divided, the blade of the knife should be carried some distance down into the spinal canal, and the spinal cord divided, together with the two vertebral arteries, which enter the skull at the occipito-spinal foramen, resting upon the basilar process of the occipital bone.

The brain may be now entirely removed, leaving behind the dura mater and its arachnoid lining; and, if it is not convenient to study the former immediately, it may be placed in alcohol, or, what is just as good, a weak solution of chloride of zinc.

MEMBRANES OF THE BRAIN.

The Cerebro-spinal Axis, comprising the brain and spinal cord, is invested by three separate membranes, namely: the dura mater, the arachnoid, and the pia mater. The cranial portions of these membranes will be examined here.

THE DURA MATER.

The Dura Mater (Fig. 178) is a dense, strong, fibrous structure, which serves not only as a protection to the parts within, but more especially as a periosteum to the internal surface of the cranial bones. It is divisible at certain points into two layers, by the separation of which venous canals are formed, and prolongations or processes that separate the cerebral hemispheres from each other and from the cerebellum. The membrane is not limited, however, to the cranial cavity, but descends into the spinal canal to invest the cord also. Its cranial portion will alone claim attention here.

The *external surface* of the dura mater is rough, and adherent to the internal surface of the cranium by small fibrous processes and minute bloodvessels. This attachment is not, however, equally firm at all points, being closest around the foramina through which the nerves have egress, and along the middle line of the vertex or top of the skull; but from the orbital plates of the frontal bone, the parietal and occipital fossæ and the squamous portion of the temporal bone, it may be torn off without difficulty. The degree of adhesion varies also at different periods of life, being much greater in old persons and children than in the middle-aged. Upon this surface may be seen the ramifications of the meningeal arteries, the most important of which is the *middle meningeal*, which spreads out in an arborescent manner over that portion of the membrane which corresponds to the parietal bone.

The *internal surface* is smooth and glistening, being lined by the external or parietal layer of the arachnoid, which is so closely connected with it as to be practicably inseparable.

The *bloodvessels* ramifying through the dura mater are the meningeal arteries and their accompanying veins, but they do not properly belong to the membrane, being distributed to the cranial bones. Like other fibrous structures it has but few bloodvessels of its own, and these are small. The presence of *nerves* has not been satisfactorily demonstrated.

The **Processes of the Dura Mater** are the falciform process of the cerebrum, the tentorium, and the falciform process of the cerebellum.

The *Falciform Process of the Cerebrum* (falx cerebri Fig. 178, 1), so called from its scythe-like shape, is situated along the middle line of the cranium, extending from the crest of the ethmoid bone in front to the middle of the tentorium behind. It is broad behind, and narrow in front, and has a superior convex and an inferior concave border; the former is occupied by the superior longitudinal sinus, and attached to the middle line of the vault of the cranium; the latter is a thin and free edge, inclosing a small vein called the inferior longitudinal sinus. Its two surfaces are covered by the parietal portion of the arachnoid, and in relation with the inner faces of the cerebral hemispheres. In the natural position it is very tense, and serves to prevent the hemispheres from impinging upon each other in sudden movements of the head.

Fig. 178.

Oblique view of interior of cranium lined by dura mater. 1, falciform process; 2, its attached border containing longitudinal sinus; 3, its free border. 4, continuation of falciform process with (6) tentorium; 7, 8, free concave edge of tentorium; 9, termination of this edge at anterior clinoid process; 10, attached border of tentorium continued along upper angle of petrous bone to postèrior clinoid process.

The *Tentorium* (Fig. 178, 7, 8) is a horizontal process which separates the cerebrum from the cerebellum. It is attached along the transverse arms of the crucial ridge of the occipital bone, the superior borders of the petrous bones, and to the clinoid processes of the sphenoid, and is covered upon both surfaces by the arachnoid. It is deeply notched in front, so as to form with the basilar process of the occipital bone an oval-shaped opening for the transmission of the peduncles of the cerebrum. Its su-

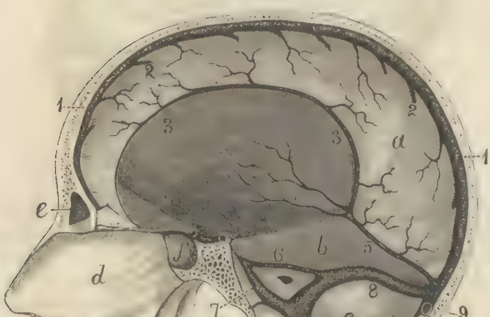
perior surface is convex, and receives the weight of the posterior lobes of the cerebral hemispheres; its inferior is concave, and corresponds to the convexity of the cerebellum.

The *Falx of the Cerebellum* is a small vertical fold, passing up from the posterior margin of the large foramen of the occipital bone to the under surface of the tentorium; it is attached to the lower vertical portion of the crucial ridge, and serves to separate the hemispheres of the cerebellum.

The *Pacchionian Bodies* are small, whitish, and granular looking, and found generally in clusters along the attached border of the falciform process. They scarcely exist in young children, but in old persons are very numerous, and often form deep depressions in the parietal bones on each side of the sagittal suture. Although generally situated upon the outer side of the membrane, they are sometimes found between its two layers, or even in the longitudinal sinus; they also sometimes exist in great numbers in the lateral ventricles of the brain. Their organization is not glandular, and their function is wholly unknown.

Sinuses of the Dura Mater.—These are venous canals for carrying off the blood from the brain, situated between the two layers of the membrane, and lined by a continuation of the internal coat of the veins. They are fifteen in number; and all communicate with each other, and ultimately terminate at the jugular foramen, where they become continuous with the internal jugular vein. Ten of the number exist in pairs, and are, on each side, the cavernous, superior and inferior petrous, occipital, and lateral. The single, five in number, are situated in the median line; they are the superior and inferior longitudinal, straight, transverse or basilar, and coronary.

Fig. 179.



Vertical section of skull, exhibiting sinuses of dura mater. 1, superior longitudinal sinus; 2, termination of superior cerebral veins; 3, inferior longitudinal sinus; 4, internal cerebral veins; 5, straight sinus; 6, 7, superior and inferior petrous sinuses of right side; 8, right lateral sinus; 9, commencement of left lateral sinus; 10, internal jugular vein. *a*, cerebral falx; *b*, tentorium; *c*, cerebellar fossa; *d*, partition of nose; *e*, frontal sinus; *f*, sphenoidal sinus.

The *Superior Longitudinal Sinus* (Fig. 179, 1) is inclosed within the attached border of the falciform process, and extends from the blind foramen in front of the ethmoidal crest to the occipital protuberance, where

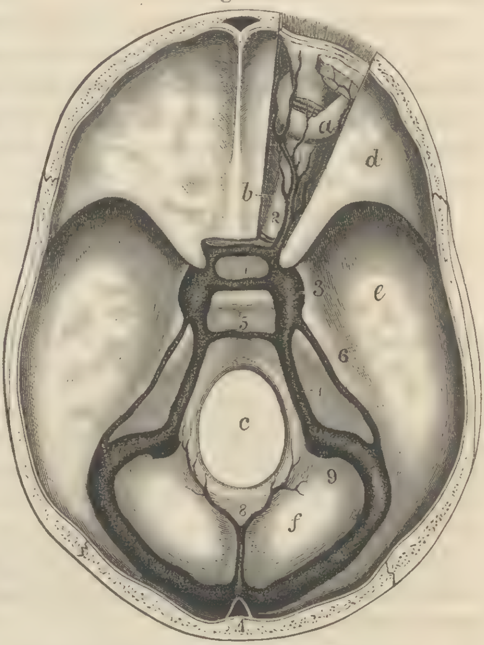
it bifurcates to form the two lateral sinuses. In order to be seen, it should be divided transversely, and then slit open. It commences very small in front, but rapidly increases in size, and, if examined just above its termination, will be found nearly large enough to admit the end of the little finger. It is triangular in shape, with one angle pointing vertically downward, and, when laid open, presents a reticulated appearance, produced by small fibrous cords, that pass between the contiguous sides for the purpose of increasing its strength. It receives the superior cerebral veins, most of which open obliquely from behind forward, by a kind of valvular perforation; also the veins of the diplöic structure of the cranial bones, and of the dura mater itself.

The *Straight Sinus* (sinus rectus, Fig. 179, 5) is situated between the base or posterior extremity of the falx and the superior surface of the tentorium, being formed by the separation of the two layers of the former, to become continuous with the superior layer of the latter. It is quite large, triangularly prismatic in shape, passes directly backward and terminates in the superior longitudinal sinus, just at its bifurcation. It receives in front the veins of Galen, hereafter to be mentioned, and the small vein called the inferior longitudinal sinus.

The *Inferior Longitudinal Sinus* is only a vein of small size, which follows along the concave border of the falciform process and terminates in the commencement of the straight sinus.

The *Lateral Sinuses* (Figs. 179 and 180) are the main canals into which all the others open, and are consequently very large. They commence opposite the internal occipital protuberance, at the bifurcation of the superior longitudinal, and the termination of the straight sinus,

Fig. 180.



Sinuses at base of cranium, with right orbit exposed. *a*, eyeball; *b*, optic nerve; *c*, occipital foramen; *d*, *e*, *f*, anterior, middle, and posterior cranial fossæ. 1, confluence of sinuses from which lateral sinus on each side passes off to terminate at jugular foramen; 2, ophthalmic vein; 3, cavernous sinus; 4, circular sinus surrounding pituitary fossa; 5, anterior occipital sinus; 6, 7, superior and inferior petrous sinuses; 8, posterior occipital sinus; 9, commencement of internal jugular vein.

and pass horizontally outward along the crucial ridge, being situated here in the attached border of the tentorium; they soon leave this, however, and, crossing the posterior inferior angle of the parietal bone on each side, enter the furrow upon the mastoid portion of the temporal bone, and terminate in the internal jugular veins at the jugular foramina. The right is usually the larger of the two.

The *Occipital Sinuses* (Fig. 180, 8), two in number, and very small, are situated along the attached border of the falx of the cerebellum; they commence on each side of the spinal opening of the occipital bone, and, frequently uniting to form a single trunk, ascend and open into the bifurcation of the superior longitudinal sinus.

The point at which the superior longitudinal, straight, and occipital sinuses unite, is situated opposite the internal occipital protuberance, and was called by the older anatomists the *press of Herophilus* (torcular Herophili), upon the supposition that the blood is here subjected to pressure.

The *Cavernous Sinuses* [3] are situated upon the sides of the body of the sphenoid bone. They are short but large, and are divided internally into several compartments by fibrous bands, and by the internal carotid arteries, and the sixth pair of nerves which pass through them. In front they receive the ophthalmic veins, and, behind, give origin to the two petrous sinuses on each side.

The *Circular Sinus*,[4] very small, surrounds the pituitary body on the pituitary fossa, and communicates on each side with the cavernous sinus.

The *Superior Petrous Sinus*,[6] also very small, originates from the cavernous sinus, passes outward and backward along the superior angle of the petrous bone, and terminates in the lateral sinus upon the mastoid portion of the temporal bone.

The *Inferior Petrous Sinus*,[7] much larger than the preceding, commences in the cavernous sinus, passes along the line of contact between the petrous bone and basilar process of the occipital, and terminates in the lateral sinus, just at the jugular foramen.

The *Basilar* or *Transverse Sinus* is a small short branch communicating between the two inferior petrous sinuses upon the upper surface of the basilar process.

THE ARACHNOID.

The Arachnoid is a thin, transparent, serous membrane, and consequently a closed sac, consisting of a parietal and a visceral layer. The *parietal layer* lines the internal surface of the dura mater and the surfaces of its processes, and is so closely adherent that it can be detached by protracted maceration alone, and then only in small pieces. The *visceral layer* covers the exterior of the brain and the sides of the fissures

occupied by the processes of the dura mater, and is attached to the subjacent pia mater by a remarkably loose areolar tissue called the *subarachnoid areolar tissue.*

During life, this areolar tissue is occupied by a serous fluid called the *cerebro-spinal liquid*, so that, strictly speaking, the arachnoid is not in contact with the pia mater, but separated from it by an interval, varying in depth at different points, called the *subarachnoid space.* This space is quite large upon the base of the brain, where the membrane extends from one prominent point to another, and is still more considerable, as will be hereafter seen, around the spinal cord, but upon the convex surfaces of the cerebrum and cerebellum it is scarcely demonstrable.

The contiguous surfaces of the arachnoid are smooth and glistening, and constantly bedewed by a serous exhalation, which, although so scanty in the healthy condition of the parts as to be barely perceptible, may, in chronic inflammation of the membrane, become so abundant as to require to be drawn off by an operation. The continuity of the parietal and visceral layers may be seen at the base of the brain; here the visceral layer will be found to form tubular sheaths for the nerves, up to the point where they leave the cavity of the cranium, whence it is reflected off to become continuous with the parietal layer. Its especial function is to prevent friction between the contiguous surfaces in the movement which the brain undergoes at each pulsation of its arteries.

THE PIA MATER.

The Pia Mater lies next the substance of the brain, and, like the dura mater and arachnoid, consists of a cranial and a spinal portion. The cranial portion is made up principally of the ramifications of the arteries of the brain, and of the radicles of its veins, held together by a small amount of fibro-areolar tissue. When finely injected, it may be traced as a continuous membrane over the whole extent of the cerebrum and cerebellum, upon the surface of and between the convolutions, and even into the ventricles.

The pia mater is the nutrient membrane of the brain, and belongs to the class of fibro-vascular structures. The cranial portion is more distinctly vascular, the spinal portion more fibrous.

ARTERIES OF THE BRAIN.

Dissection.—To expose the arteries of the brain, remove the visceral layer of the arachnoid and the subarachnoid areolar tissue from the base of the brain, and trace out each vessel separately, taking care not to cut or lacerate the cerebral substance, nor to tear away the origins of the nerves.

The Arteries of the Brain are four in number, and not remarkably large, considering the size and activity of the organ which they supply. They are the two vertebral and the two internal carotid arteries.

The **Vertebral Arteries** (Fig. 182) originate from the subclavian, deep in the lower part of the neck, and ascending through the foramina in the transverse processes of all the cervical vertebræ, excepting the seventh, they enter the cavity of the skull from opposite sides of the occipito-spinal foramen. From this point (where it is supposed they have been divided in removing the brain) they converge upon the basilar process of the occipital bone, and opposite the posterior margin of the large prominence on the under surface of the cerebellum, known as the Varolian bridge, they unite to form a single trunk, called the basilar artery, which, running forward to the distance of an inch or more, divides into four branches, two on each side. Before uniting, however, the vertebral arteries give off the following branches: 1. The *Anterior Spinal*, a small twig that originates by two roots, one from each of the main trunks, and descends in front of the spinal cord to its inferior extremity. 2. The *Posterior Spinal*, one on each side, and very small, which winds around the upper extremity of the cord, and descends upon its posterior surface without uniting with its opposite fellow. 3. The *Posterior Meningeal*, a mere twig distributed to the dura mater in the vicinity of the spinal opening of the occipital bone. 4. The *Inferior Cerebellar*, a considerable branch, originating from the vertebral just before it unites with its fellow to form the basilar, and often from the basilar itself, and passing out in a tortuous manner to the under surface of the cerebellum to which it is distributed. It gives off a small twig, which enters the internal auditory meatus, to be distributed to the internal ear.

The **Basilar Artery** (Fig. 182), formed as above mentioned, is situated in the median line between the basilar process and the under surface of the Varolian bridge. It is about the size of a crowquill; gives off in its course several small branches, and terminates in front of the bridge by dividing into the two superior cerebellar and the two posterior cerebral arteries. The *superior cerebellar* pass from their origin immediately around to the superior parts of the cerebellum, upon which they are distributed. The *posterior cerebral* originate just in front of the preceding, from which they are separated by the third pair of nerves; they proceed forward for a little way to receive the posterior communicating arteries—a small branch from the internal carotid on each side—and then wind outward upon the under surface of the posterior lobes of the cerebrum.

The **Internal Carotid Artery** (Fig. 182) of each side enters the cavity of the cranium through the carotid canal in the petrous bone, and inclines forward, resting upon the side of the pituitary fossa, and inclosed by the cavernous sinus. Having reached the anterior clinoid process, it bends almost directly upward beneath, and upon the inner side of this

process, and divides upon the base of the brain into the following branches: 1. The *anterior cerebral*, quite a large vessel, which runs forward and inward to the anterior termination of the antero-posterior fissure that separates the two hemispheres of the brain; communicating here with its opposite fellow by a very short trunk, called the *anterior communicating artery*, and then entering the fissure, curving backward along the inner side of the corresponding hemisphere as far as its posterior lobe. 2. The *middle cerebral artery*, also quite large, which passes outward into the fissure of Sylvius that separates the anterior and middle lobes of the brain, and subdivides into branches for the supply of the middle parts of the hemisphere. 3. The *posterior communicating artery*, very small, which runs directly backward to join the posterior cerebral, a branch of the basilar.

It will be seen that, by the short transverse branch connecting the two anterior cerebrals, and by the two posterior communicating branches which extend between the internal carotid on each side and the two posterior cerebrals, that a complete vascular circle is formed, commonly called the *circle of Willis*. The object of this free anastomosis is to allow all parts of the brain to be equally supplied with blood, when, from any cause whatever, the circulation may be impeded or arrested in any one of the main trunks. It is also owing to this free communication that the surgeon is enabled to tie one or even both the carotids in the neck, without material injury to the functions of the brain.

The *veins* of the brain do not accompany the arteries, but open into the sinuses. (See page 398.)

Dissection.—After completing the study of the membranes and vessels, the student may proceed to the dissection of the brain itself, or this may be deferred until a more convenient time, and the face or the neck commenced upon. If, however, there is no danger of the rest of the subject spoiling, the brain should be gone through with at once.

THE BRAIN.

Under the general term Brain or Encephalon, is ordinarily included all that part of the cerebro-spinal centre contained within the cavity of the skull. It is irregularly oval in shape, with its long diameter directed antero-posteriorly, and its large extremity presenting backward. Its lower surface is irregularly flattened, and constitutes what is called the *base of the brain*, which rests upon the floor of the cranium.

The size of the brain is subject to great variety, but its average weight, as deduced from the observations of a number of authors,* is 49½ oz. (avoirdupois) for the male, and 44 oz. for the female. The maximum weight is

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* Table in Sharpey and Quain's Anatomy.

stated at 65 oz.,* and its minimum 34 oz. The weight does not seem to be always proportionate to the size of the cranial cavity,† and in the human subject, at least, bears no fixed relation to the size of the body.

The weight of the human brain being taken at about 3 lbs. (48 oz.), it is found to be absolutely heavier than the brain of all the lower animals, except the elephant and whale. In the elephant, the brain, according to Perrault, Moulins, and Sir A. Cooper, weighs between 8 and 10 lbs.; while that of the whale was found by Rudolphi, in a specimen 75 feet long, to weigh upwards of 5 lbs.‡

Fig. 181.

Plan in outline, showing, in lateral view, parts of encephalon separated somewhat from each other. A, cerebrum; *f, g, h,* its anterior, middle, and posterior lobes; *e*, fissure of Sylvius; B, cerebellum; C, Varolian bridge; D, medulla oblongata; *a*, peduncles of cerebrum; *b*, superior, *c*, middle, *d*, inferior peduncles of cerebellum; parts marked *a, b, c*, C, form isthmus of encephalon.

It also varies considerably in consistence, being sometimes so soft as to spread out and lose its natural shape entirely when placed upon a flat surface, and again so firm that it may be rolled about quite rudely without injury. Its specific gravity is very little greater than that of water.

The brain is divided into three well-defined parts, named the cerebrum, cerebellum, and medulla oblongata, each of which will be separately considered.

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* Cuvier's brain, the largest on record, weighed upwards of 64 oz., and that of the late Dr. Abercrombie 63 oz.—*Op. cit.*

† The brain of the late Daniel Webster weighed only 52 oz., whereas the cranial cavity was next to the largest on record.

‡ Tiedemann, quoted by Sharpey and Quain.

THE CEREBRUM.

The Cerebrum occupies all that part of the cranial cavity situated above and in front of the tentorium, and comprises about six-sevenths of the entire weight of the brain. It is somewhat oval in shape, with its large extremity presenting backward; is irregularly flattened upon its under surface or base, and marked over the whole of its exterior by winding elevations, called convolutions, separated by intervening depressions termed sulci. A deep fissure (longitudinal fissure) extends throughout its whole length in the median line above, lodging the falciform process of the dura mater, and dividing the organ into two lateral halves, called *hemispheres*. Each hemisphere is subdivided upon its basilar surface into three lobes, an anterior, a middle, and a posterior.

The *anterior lobe* rests upon the roof or superior wall of the orbit of the eye, and is correspondingly concave upon its under surface. It is separated from the middle lobe by a deep groove, called the *fissure of Sylvius*, which, commencing at the middle of the base of the organ, curves forward and outward, and then upward, and lodges the posterior edge of the lesser wing of the sphenoid bone. The *middle lobe* is prominently convex, and occupies the middle fossa at the base of the skull. The *posterior lobe* is not defined from the preceding by any line or fissure, the two forming properly only one lobe, but it is considered as comprising so much of the organ as rests upon the tentorium, behind the upper edge of the petrous portion of the temporal bone.

Convolutions.—The three free surfaces of each hemisphere, namely, the base, the external convex and the internal flat surface presenting toward the falx, are all marked by the convolutions and furrows just mentioned. The number of these convolutions cannot be accurately stated on account of their continuity with each other, and the irregularity of their distribution in different individuals. Their size is also subject to great variation, both in different persons and at different periods of life. The intervening sulci or anfractuosities, as they are sometimes called, are properly only involutions or a doubling in of the surface, and vary, as do the convolutions, in their depth, size, and prominence.

The great number and size of the convolutions and involutions of the cerebrum distinguish the brain of man from that of all other animals, and, as the principal object of this configuration seems to be to increase the extent of the free surface of the organ, it is presumable that the superior mental endowment of man over all other animals, and of one individual over another, is due to the same circumstance,—a supposition that is in some degree confirmed by the fact that, in idiots, the convolutions are found to be comparatively few, and of a remarkably small size. The gray matter gives a dark appearance to the convolutions externally.

Base of the Cerebrum.—Before proceeding to the dissection of the interior of the cerebrum, the student should make himself acquainted with the principal points of interest upon the base of the organ, deferring the origins of the nerves for a subsequent examination. For this purpose the areolar tissue and bloodvessels in this situation should be carefully removed, leaving the nerves untouched. The following are the principal objects worthy of attention, and are all well defined in the accompanying plate.

Fig. 182.

Base of brain. 1, bulb of olfactory nerve; 2, optic nerve; 3, anterior perforated space; 4, optic tract; 5, peduncle of cerebrum; 6, motor-ocular nerve; 7, trochlea or fourth nerve; 8, trifacial or fifth nerve; 9, abducent or sixth nerve; 10, anterior pyramid; 11, olivary body; 12, vertebral artery; 13, anterior spinal artery; 14, anterior cerebral artery, branch of internal carotid; 15, gray lamina; 16, middle cerebral artery; 17, gray tuber; 18, mammillary body; 19, middle perforated space; 20, posterior cerebral artery, branch of basilar; 21, superior cerebellar artery; 22, Varolian bridge; 23, inferior cerebellar artery; 24, facial and auditory nerves; 25, glossopharyngeal, pneumogastric, and spinal accessory nerves; 26, hypoglossal nerve; 27, cerebellum.

In the middle line in front is the anterior termination of the great *Interhemispheric* or *Longitudinal Fissure*, which here separates the two

anterior lobes of the cerebrum, and lodges the anterior extremity of the falciform process of the dura mater. Upon either side of the fissure, and occupying an antero-posterior furrow upon the base of the anterior lobe, is the *Olfactory Nerve*, terminated in front by an enlargement known as the *Olfactory Bulb.*

Immediately behind the fissure in the median line lies the *Optic Commissure* or *Chiasm*, formed by the crossing of the fibres of the optic tracts; it is situated, when the brain is in its place, upon the olivary process of the sphenoid bone just in front of the pituitary fossa. Externally to the commissure, and at the commencement of the fissure of Sylvius, which separates the anterior from the middle lobe, may be observed a small triangular space perforated by a number of small vessels and called the *Anterior Perforated Space* (substantia perforata); the olfactory nerve originating apparently from this spot.

Directly posterior to the optic commissure is a small, circular, grayish-looking elevation named the *Gray Tuber* (tuber cinereum), from the centre of which is given off a small cylindrical prolongation, about half an inch long, called the *Infundibuliform Process;* the former forms the floor of the third ventricle, and is very thin, while the latter contains a minute canal, communicating with the ventricle, but having no external outlet.

Attached to the lower extremity of the infundibuliform process is the *Pituitary Body*, which, in the removal of the brain, is generally left in the pituitary fossa; it is transversely oval in shape, of a dull gray color and soft consistence, but very vascular.

Behind the gray tuber are two white bodies, about the size and shape of split peas, and named the *Mammillary Bodies* (corpora albicantia) or the white bodies of Willis. Behind these is an angular depression perforated by numerous small bloodvessels, and called the *Middle* or *Posterior Perforated Space* (locus perforatus). Forming the lateral boundaries of the middle perforated space are the *Peduncles of the Cerebrum* (crura cerebri), two large white fibrous-looking masses which diverge from behind forward and upward, and are continued into the interior of the hemispheres. They contain internally an irregular mass of gray substance called the *black spot* (locus niger).

Crossing the peduncles behind is the large white rounded eminence known as the *Annular Protuberance* or *Bridge of Varolius* (pons Varolii), the fibres of which pass transversely outward into the hemispheres of the cerebellum, and constitute its middle peduncles.

Dissection.—Turn the brain upon its base, press the two hemispheres gently asunder, and at the bottom of the fissure divide the arachnoid membrane where it stretches across, and the superior surface of the *great cerebral commissure* or *corpus callosum* will be brought into view. Next, introduce a scalpel into the fissure, and, with the blade placed flatwise, dissect off, by repeated horizontal strokes from within outward, one of the hemispheres on a level with the com-

missure. The gray and white substances of which the brain is composed may now be readily distinguished.*

Interior of the Cerebrum.—The appearance presented upon a transverse section of one hemisphere on a level with the great commissure, is called the *small oval centre* (centrum ovale minus), consisting of an oval plane surface of white medullary substance, bordered by a zigzag line of gray, except along the continuity of the commissure.

The *Gray* or *Cortical Substance*, constituting the border or superficial portion of the cerebrum, is spread out over nearly the whole of the exterior in the form of a continuous layer, varying from one to two or three lines in thickness, and so folded upon itself as greatly to exceed the superficial surface of the organ. This folded arrangement, forming the convolutions and involutions, is well seen upon this cross section, and from it some idea may be had of the large extent that the layer would cover, if it were dissected off entire, and spread out upon a plane surface. The depth to which the involutions reach may be also noticed; some of them measuring an inch or more from the surface, and others not more than two or three lines.

Fig. 183.

Transverse section of hemispheres of cerebrum on a level with corpus callosum. 1, white substance of hemispheres, dotted with divided capillary vessels; 2, gray substance on convoluted exterior; 3, corpus callosum, with direction of its fibres indicated by transverse striæ; 4, longitudinal median striæ; 5, anterior and posterior portions of great longitudinal fissure.

The *White* or *Medullary Substance* is inclosed by the cortical layer, and constitutes by far the larger part of the organ. In its fresh state it is soft but tenacious, of a clear yellowish-white color, and apparently of a homogeneous nature throughout. When, however, hardened by maceration in alcohol or any other fluid capable of coagulating albumen, it may be shown to consist of white nerve fibres, held together by a very delicate network of areolar tissue and capillary vessels. The fibres of which it is composed are either continuations of the spinal cord and nerves at the base of the brain, or else they extend only from one part of the organ to another, for the purpose of connection and association, forming what are known as the commissures of the brain.

* For an account of the structure of the nervous centres, see page 49.

The largest of these commissural masses is the *Great Cerebral* or *Interhemispheric Commissure* (named by the older anatomists the *Corpus Callosum*, upon the supposition that it was the hardest part of the brain), of which one-half of the superior surface has been exposed by the transverse section. This commissure is situated at the bottom of the longitudinal fissure, and it will be observed that it does not extend directly from the lateral surfaces of the fissure, but that each hemisphere overhangs it slightly, and admits the introduction of the handle of the scalpel to the distance of at least a quarter of an inch.

Dissection.—If the other hemisphere be now divided upon a level with the one that has already been dissected off, the whole of the superior surface of the commissure will be brought into view. The appearance presented after this section has been made is termed the *large oval centre* (centrum ovale majus).

The great cerebral commissure (Fig. 183) extends from within an inch and a half of the anterior extremity of the cerebrum, to within two and a half of the posterior. It is about three inches in length, convex above, and marked in the median line by a slight ridge or raphe, which corresponds to the bottom of the longitudinal fissure, and is supposed to indicate the original development of the brain by two distinct halves, and their union in the middle line. Its anterior and posterior extremities are rounded off and turned down. Its under surface forms the roof or ceiling of the lateral ventricles.

The great cerebral commissure is composed entirely of white or medullary substance, and its fibres run transversely between the hemispheres, in the interior of which they may be traced outward in every direction, toward the gray substance of the exterior.

Dissection.—To expose the lateral ventricles, make a longitudinal division of the great commissure upon each side of the raphe, leaving a strip about a fourth of an inch wide along the middle; turn the lateral flaps aside and cut them off.

The *Lateral Ventricles* (Fig. 184) are two large, irregular cavities, flattened from above downward, and separated from each other by an imperfect middle wall of medullary substance, called the *interventricular* or *translucent septum* (septum lucidum). The septum consists of two thin laminæ, which are continuous above with the under surface of the great commissure, and inclose, in front, a minute isolated cavity called the *fifth ventricle.*[10] In order to see these layers and the included cavity, it is necessary to divide the septum in a horizontal direction by means of scissors. The lower edge of the septum is continuous behind with the superior surface of the fornix, and extends downward in front very nearly to the base of the brain.

Each lateral ventricle is considered as having a body or main cavity, and three prolongations called horns (*cornua*). The *anterior horn*[5] is the anterior angle of the cavity; it lies in the anterior lobe of the cere-

brum, is short and blunt, and directed obliquely forward and outward, diverging from its opposite fellow. The *posterior horn*,[7] situated in the posterior lobe, is long, narrow, and curved, with its concavity presenting toward the middle line; it often reaches within a few lines of the exterior of the cerebrum. The *middle horn*[6] (exposed by removing a wedge-shaped piece from the side of the hemisphere), also long and narrow, starts from the body of the cavity immediately in front of the commencement of the preceding, and leads in a very tortuous manner from behind downward, forward, and inward, into the interior of the middle lobe.

The ventricles are lined by a pavement epithelium, and upon the floor of each the following objects of interest may be seen without farther dissection:

The *Striated Body* (corpus striatum[8]) is a large ovoidal mass of gray substance mixed with white fibres, situated in the anterior lobe of the hemisphere, and projecting by its superior surface into the cavity of the ventricle. Its intraventricular portion is pyriform in shape; the large extremity occupies the anterior horn, and the small or narrow portion is directed backward and outward, diverging from its fellow of the opposite side. It is covered by the lining epithelium of the cavity, crossed by one or two small veins, and traversed from below and behind by the fibres of the peduncle of the cerebrum, on their way toward the cortical layer of the brain. The white fibres cannot, however, be seen without making an antero-posterior section of the organ, which is not advisable at this stage of the dissection. Along the inner margin of the striated body is a small strip of yellowish-white substance called the *horny lamina* (lamina cornea), which seems to be a thickening of the epithelium in this situation, and conceals the large vein of the striated body. Remove the lamina and vein, and a small white line called the *semicircular band* (tenia semicircularis *vel* striata[17]), which separates the striated body from the optic bed, will be brought into view.

Fig. 184.

Transverse section of cerebral hemispheres, corpus callosum removed, and lateral ventricles exposed. 1, white substance of interior of cerebral hemispheres; 2, gray substance of exterior convoluted surface; 3, 4, anterior and posterior extremities of corpus callosum; 5, anterior horn of left lateral ventricle; 6, middle or descending horn; 7, posterior horn; 8, striated body; 9, translucent septum; 10, fifth ventricle; 11, fornix; 12, posterior crus of fornix; 13, attachment of fornix to under part of corpus callosum; 14, hippocampus; 15, fimbriated body; 16, small hippocampus; 17, semicircular line; 18, choroid plexus; 19, edge of thalamus.

The *Optic Bed* (thalamus nerve optici[19]) is situated behind the striated body, and upon the inner side of its posterior or divergent portion. It forms an ovoidal prominence in the body of the ventricle, but, being mostly concealed by the choroid plexus and fornix, cannot be satisfactorily examined until these structures have been removed.

The *Choroid Plexus*[18] is a roll of convoluted vessels, principally minute arteries, which ascends from the middle horn of each ventricle, passes forward and inward over the superior surface of the optic beds, and through the foramen beneath the anterior extremity of the fornix. It is covered by a reflection of the epithelial lining of the cavities, and has not unfrequently appended to its border clusters of little spherical bodies, in every respect similar to the Pacchionian bodies found along the superior longitudinal sinus.

The *Fornix*[11] is a flat triangular plane of medullary substance, situated upon the floor of the ventricles, with its base presenting backward. Its superior surface is continuous with the interventricular septum: its inferior covers in the third ventricle, from which it is separated by a thin transparent membrane. Its anterior extremity or apex dips down toward the base of the brain in front of the optic beds, and separates into two rounded legs (crura) or pillars, which may be traced as far as the mammillary eminences. Posteriorly it is continuous upon each side with the two hippocampi found in the middle and posterior horns, and with the posterior border of the great commissure. Being composed entirely of white fibres, the direction of which is from before backward, the fornix may be looked upon as an antero-posterior commissure of the cerebrum.

Beneath the anterior extremity of the fornix is a considerable opening called the *foramen of Monro*, through which the choroid plexus passes, and the two lateral ventricles communicate with each other and with the third ventricle.

Dissection.—Divide the fornix in front, where it arches over the choroid plexus, and turn it carefully back. Upon its under surface will sometimes be seen an impression made by the subjacent vessels, called by the older anatomists the *lyre*, from its fancied resemblance to the musical instrument of that name.

The thin, weblike, transparent membrane, lying beneath the fornix, and now brought into view, is the *Choroid Membrane* (velum interpositum), which seems to be a process of the pia mater, pushed into the ventricles beneath the posterior extremity of the great commissure and fornix. It incloses in its margins the choroid plexus, and, in the median line, the veins of Galen. It is in relation above with the under surface of the fornix, and below with the optic beds, the third ventricle, and the pineal and quadrigeminal bodies.

The *veins of Galen*, generally two in number, receive the blood from the veins of the striated bodies and optic beds, pass directly backward

beneath the posterior extremity of the fornix, and open into the anterior extremity of the straight sinus of the dura mater. It is around these veins that Bichat supposed a communication to exist between the arachnoid sac and the cavity of the ventricles; but this is now known not to be true, the arachnoid being reflected from the circumference of the vein, just beyond the termination of the latter in the straight sinus.

Upon the lower side of the choroid membrane two small vascular fringes may sometimes be noticed, projecting downward between the optic beds, and named the *choroid plexus of the third ventricle.*

Dissection.—Turn the choroid membrane backward, together with the choroid plexus, and dissect it carefully from the pineal body which lies in the middle line between the optic beds behind.

The *Optic Bed* (Fig. 185, 15), the superior surface of which is now clearly brought into view, is a large irregularly ovoidal mass of a light grayish color, occupying the middle parts of the cerebral hemispheres; its long axis is directed antero-posteriorly, and nearly parallel with that of its fellow of the opposite side. Its superior surface is smooth, convex, broader behind than before, forms part of the floor of the lateral ventricle, and is crossed by the fornix, and choroid plexus. Externally it is continuous with the substance of the corresponding hemisphere and striated body. Its internal surface presents toward the median line, and is separated from that of the other side by the deep fissure, known as the third ventricle. The inferior rests upon, and is continuous with the peduncles of the cerebrum, the fibres of which traverse the lower part of the bed on their way to the superficial parts of the brain. The posterior extremity is broad and smooth, and forms the anterior boundary of the middle horn of the lateral ventricle; the anterior is narrow, and imbedded in the posterior internal surface of the striated body.

Fig. 185.

Transverse perpendicular section through the brain. 1, interhemispheric or great cerebral commissure; 2, lateral ventricle; 3, third ventricle; 4, striated body; 5, optic bed; 6, mammillary body; 7, choroid plexus; 8, fornix; 9, pituitary body.

Like the striated body the optic bed is one of the primitive ganglia of the brain, and, as the former is supposed by some physiologists to be the seat of animal sensation, the latter is thought to be the centre of motion.

Although denominated the optic beds, these bodies have no immediate connection with the optic nerves.

The *Third Ventricle* is the narrow fissure situated between the optic thalami, and extending from the pillars or legs of the fornix in front to the quadrigeminal bodies behind. It is roofed in by the choroid membrane and fornix, and its floor is formed by the gray tuber and interpeduncular space of the base of the brain. Its lateral walls are incrusted by a thin layer of gray substance, and united in the middle by a broad transverse band of the same material, called the *middle* or *soft commissure* (commissura mollis, Fig. 186, $_{11}$). At the anterior extremity of the third ventricle is the *anterior commissure*,[12] a rounded cord of medullary substance, deeply situated just in front of the pillars of the fornix, and extending transversely from the middle lobe and striated body of one hemisphere to similar parts of the other. It may be seen projecting slightly into the ventricle, by looking between the pillars of the fornix from behind. The *posterior commissure* is a narrow band of medullary matter, extending between the optic beds at the posterior extremity of the third ventricle. It forms the superior margin of the entrance to the aqueduct of Sylvius, a narrow canal which leads backward from the third to the fourth ventricle.

The third ventricle is prolonged below into the infundibular process of the base of the brain, in the form of a very minute blind canal, through which the old anatomists, not knowing the canal to be closed, supposed the secretions, which they fancied the brain produced, were drained off into the nasal cavities. Above, it communicates with the lateral ventricles through the foramen of Monro, and behind, with the fourth ventricle, by the aqueduct or canal of Sylvius.

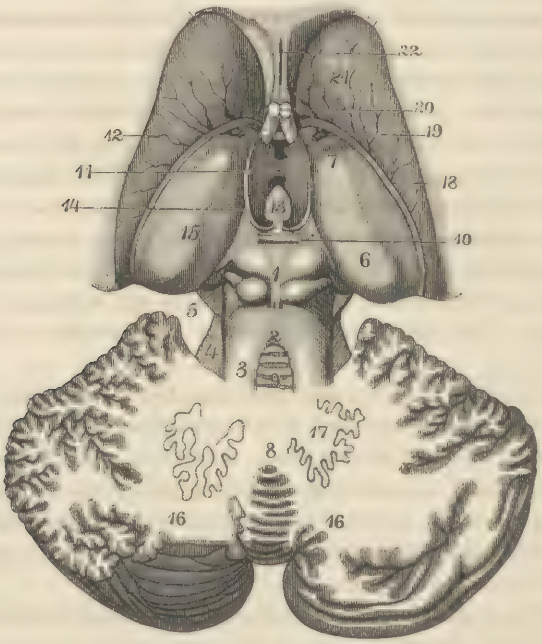
The *posterior horn* of the lateral ventricle is a digital prolongation of the cavity into the posterior cerebral lobe. It curves backward with its convexity directed outward, and ends in a blind extremity near the inner surface of the hemisphere posteriorly. It differs in its extent in different individuals, and often in the two hemispheres. Upon its inner wall is a small elliptical prominence called the *small hippocampus* (hippocampus minor, Fig. 184, $_{16}$), which corresponds to one of the involutions or sulci of the surface of the organ.

Dissection.—To obtain a correct idea of the middle horn of the lateral ventricle, it is requisite to remove a tolerably large wedge-shaped section from the outer side of the hemisphere, involving a considerable portion of the middle lobe, the base of the section presenting externally, as represented in Fig. 184. In this way the cavity may be opened along its whole course, and viewed from without.

The *middle horn* or *cornu* of the lateral ventricle is a narrow prolongation of the cavity, commencing just behind the optic bed, and descending forward, in a somewhat curved manner, in the middle lobe of

the hemisphere, toward the base of the brain. Upon its posterior inferior wall will be observed a long prominent roll of medullary substance, called the *great hippocampus* (hippocampus major, Fig. 184, $_{14}$), which is only the convex portion of one of the involutions of the brain; it terminates at the bottom of the cavity in a nodulated extremity called the *foot* of the hippocampus, which bears some resemblance to the clinched hand.

Fig. 186.



Striated bodies, thalami, quadrigeminal body, and cerebellum. 1, quadrigeminal body; 2, valve of brain; 3, superior peduncle of cerebellum; 4, superior portion of middle peduncle; 5, superior portion of crus of cerebrum; 6, posterior tubercle of thalamus; 7, anterior tubercle; 8, fundamental portion of cerebellum; 9, process of gray substance resting on valve of brain; 10, posterior commissure of third ventricle; 11, middle commissure; 12, anterior commissure; 13, pineal body turned forward; 14, its peduncle; 15, thalamus; 16, hemispheres of cerebellum; 17, dentated body; 18, semicircular line; 19, vein of striated body; 20, anterior crura of fornix; 21, striated body; 22, fifth ventricle between layers of translucent septum.

Upon the surface of the great hippocampus is the choroid plexus, the vessels of which enter the cavity from below, and beneath this is the continuation of the outer edge of the fornix, under the name of the *fimbriated body*.

Dissection.—Cut away the posterior extremity of one cerebral hemisphere by an incision, extending from just behind the optic bed, downward and forward to the base of the hemisphere. Clear away the vessels and cellular tissue from the parts thus exposed, taking care not to tear away the fourth nerve and the pineal body, and a good view will be had of the following important structures.

The *Quadrigeminal Bodies* (corpora quadrigemina, Fig. 186, 1) are four rounded prominences collected into a quadrangular-shaped group, situated behind the third ventricle, and partly between the posterior extremities of the optic thalami. They are separated from each other by a crucial depression, and form, therefore, two pairs, denominated the *nates* and *testes*, of which the former are somewhat the larger, and placed above and a little in front of the latter. Although apparently composed only of medullary substance, these bodies inclose a quantity of gray or cineritious matter, and are considered as constituting one of the five primitive ganglia of the brain. They are continuous in front with the optic beds, and rest upon the peduncles of the brain below.

Surmounting the quadrigeminal bodies in the median line is the *Pineal Body* or *Conarium*,[13] a small conoidal-shaped body of gray substance, with its base presenting forward, and attached along the superior internal edge of the optic beds by two little bridles or peduncles of medullary substance. Its structure is similar to that of the gray substance of the exterior of the brain, except that it generally contains one or more grains of earthy matter, which feels like sand between the fingers, and is found to consist principally of phosphate and carbonate of lime. The function of this little organ is as entirely unknown as, indeed, that of most other parts of the brain. It was the fanciful conceit of Des Cartes that it was the seat of the soul, and that, by the two little peduncles or reins, it governed the movements of the body.

Near the point of junction between the quadrigeminal bodies, and the optic beds on each side, and beneath the posterior margin of the latter, are two grayish elevations, about the size and shape of coffee-grains, called the *Geniculate Bodies*, of which one is *internal* or nearer the median line, and the other *external*. They are connected to the surrounding parts by medullary substance, and are the principal points of origin of the optic nerves.

The *Cerebellar Testicular Process* or superior peduncle of the cerebellum (Fig. 186, 3) is a broad white band of medullary substance extending from the cerebellum to the testes, beneath which its fibres are continued on to the cerebrum. It is oblique in its position, about an inch in length, a quarter of an inch broad, and convex upon its external surface. It is continuous in the median line with its opposite fellow, by a very thin bridge of grayish substance, called the *valve of the brain*, which forms the superior wall of the canal leading from the third to the fourth ventricle. The superior extremity of the valve is connected to the quadrigeminal bodies, or rather to the inferior termination of the vertical groove that separates these bodies, by a well-marked pillar or bridle of white substance. Upon each side of this bridle may be observed the roots of the fourth pair of nerves. The inferior extremity of the valve spreads out to form a part of the superior wall of the fourth ventricle.

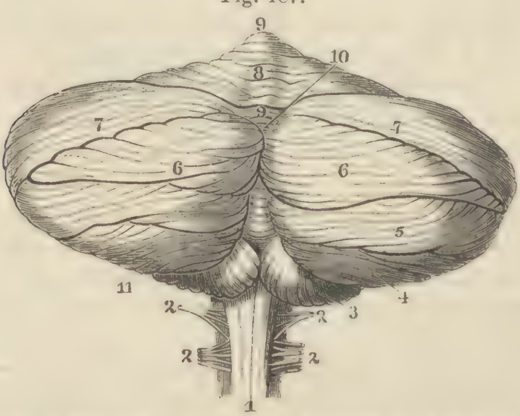
THE CEREBELLUM.

The Cerebellum or Small Brain occupies the posterior fossæ of the base of the skull, and is separated from the posterior lobes of the cerebrum by the tentorium, which supports the weight of the latter upon its superior surface. It is transversely oval in shape, somewhat flattened in a vertical direction, but convex upon its two surfaces, and is divided by a median groove below, called the *valley*, into two lateral hemispheres. The posterior extremity of the valley forms a deep notch, which lodges the falciform process of the cerebellum.

The exterior of the cerebellum is not arranged in large convolutions like the surface of the brain, but is marked by numerous fine ridges, which run for the most part transversely (longitudinally as respects the axis of the organ), and are separated by corresponding grooves or fissures. Upon making a section of the organ, these ridges will be found to consist of concentric laminæ or plates of various sizes, composed in a great measure of gray substance. This substance does not, however, form a continuous layer, but is wanting at the bottom of many of the deeper fissures, as may be seen by pressing the plates asunder.

Upon the upper surface of the cerebellum, the union of the two hemispheres is indicated by a median ridge called from its serpentine form the *superior vermiform process* (Fig. 187, $_9$), in crossing which the concen-

Fig. 187.



Posterior view of cerebellum. 1, spinal cord; 2, 2, posterior spinal nerves; 3, amygdaloid lobules; 4, 5, 6, 7, right hemisphere of cerebellum; 8, 9, superior vermiform process; 10, commencement of inferior vermiform process; 11, pyramid.

tric plates and intervening furrows make short curves with their convexities forward. In the bottom of the valley, upon the under surface, will be seen a similar ridge called the *inferior vermiform process;*[10] in the course of which three small elevations present themselves, named, in the

order of their succession from behind forward, the *pyramid*, *uvula*, and *nodule*. Upon the sides of the valley opposite the uvula are two large rounded prominences, called, from their resemblance to a pair of swollen tonsils, the *amygdaloid* or *tonsillitic lobules.* In front of these, and more external, are two smaller masses, called the *pneumogastric lobules* or *flocculi*, which are connected to the cerebellar hemispheres by a delicate white peduncle, and continuous with each other by transverse white fibres forming a kind of crest convex before and concave behind, called the *inferior medullary veil* (velum). This veil constitutes a part of the posterior inferior wall of the fourth ventricle.

Besides these, there are other divisions, such as the *digastric*, *gracilis*, and *semilunar lobes*, mentioned by authors as occurring upon the inferior surface; but it is scarcely necessary, in a work of this kind, to mention their names.

Dissection.—Make a clean vertical division of the cerebellum in the middle line from behind down to the medulla oblongata, so as to lay open the fourth ventricle.

The **Fourth Ventricle** of the brain is an elongated lozenge-shaped cavity, about an inch long and half an inch wide, situated behind the medulla oblongata and beneath the anterior border of the cerebellum. Its anterior or inferior wall, formed by the posterior surface of the medulla oblongata, and called from its fancied resemblance to a quill-pen, the *calamus scriptorius*, is oblique from above downward and backward, shaped like a diamond on playing cards, and traversed in the median line by a continuation of the posterior fissure of the spinal cord. At its inferior angle is a slight depression called the *cavity* or *ventricle of Arantius*, which marks the entrance to the central canal existing in the spinal cord of the fœtus. The surface is covered by a thin coating of gray substance, and upon it may be seen a number of white fibres which converge toward its outer angle to form the auditory nerve (Fig. 188, $_6$).

The posterior superior wall of the ventricle is hollowed out, as it were, of the anterior margin of the cerebellum, which is here continuous above with the superior peduncles[4] and valve, and below with the tonsillitic and pneumogastric lobes.

The anterior or superior extremity of the cavity is continuous with the canal leading from the third ventricle (aqueduct or canal of Sylvius), which may be readily seen by passing a probe or grooved director from above, and dividing the superjacent valve. The inferior extremity is imperfectly closed by the pneumogastric lobes, between which Magendie demonstrated the communication of the cavity with the subarachnoid space; the arachnoid membrane being here stretched across from the hemispheres of the cerebellum to the spinal cord, so as to form a considerable interval, occupied for the most part by areolar tissue and blood-

vessels. At this point, also, the pia mater enters the ventricle, and forms a small vascular fringe, somewhat similar to the choroid plexus of the lateral ventricles.

Fig. 188.

Diagram of fourth ventricle and restiform tracts. 1, optic bed; 2, nates and testes; 3, origin of fourth nerve; 4, cerebellar testicular processes; 5, fibres of restiform body entering cerebellum; 6, origins of auditory nerve from floor of fourth ventricle.

If the student will now examine the sides of the vertical section already made, he will observe the peculiar arrangement of the *Gray* and *White Substances* of the organ. It has been already stated, that the gray or cortical substance is disposed in the form of plates or lamellæ of various sizes, but it will now be seen that it is properly the medullary substance which forms these plates, the gray matter only incrusting their lateral surfaces and free edges. It is this lamellar arrangement of the white substance that gives to the section the beautiful arborescent appearance called the *arbor vitæ.*

In the midst of the central mass of white substance from which the lamellæ are prolonged, but somewhat nearer the superior than the inferior surface of the organ, is a small yellowish body, called the *rhomboïd* or *dentated body.* It consists of a thin, irregularly involuted capsule of gray substance, filled with a plexiform mass of medullary fibres, which enter and emerge from it at all points.

The cerebellum is continuous with the cerebrum through the cerebellar testicular processes (superior peduncles of the cerebellum), and with the medulla oblongata by means of the restiform bodies (inferior peduncles), hereafter to be described. The two hemispheres, although intimately bound together by continuity of tissue, are also provided with a separate commissure, already mentioned, under the name of the bridge of Varolius,

the fibres of which, as they leave the organ on either side, are collected into a large well-marked bundle called the middle peduncle of the cerebellum.

BRIDGE OF VAROLIUS.

The Bridge of Varolius or Annular Protuberance (*pons Varolii*, Figs. 182 and 189) is a large prominent quadrangular body situated in front of and above the medulla oblongata. Its inferior surface is convex, rests upon the basilar process of the occipital bone, is closely invested with dense pia mater, and slightly grooved in the middle line for the basilar artery. It is composed of white fibres which pass transversely outward to form the *middle peduncles of the cerebellum*, and constitutes therefore a commissure between the hemispheres of the latter. It crosses at right angles the continuation of the anterior tracts of the medulla oblongata, and upon each side, about half an inch from the middle line, its fibres separate to give passage to the roots of the fifth nerve, which has the appearance of originating from the bridge itself, but in reality comes from the continuations of the medulla oblongata beneath. The sixth pair of nerves will also be seen crossing its inferior border and resting upon its convex surface.

THE MEDULLA OBLONGATA.

The Medulla Oblongata, the third and smallest division of the brain, is properly the expanded upper extremity of the spinal cord, the only boundary line between the two being the margin of the great foramen of the occipital bone. It measures little more than an inch in length, and terminates, apparently, in front at the bridge of Varolius, although its anterior fibres, as already stated, continue upward beyond the latter to form the peduncles of the cerebrum. In its natural position it rests upon the basilar process of the occipital bone, is overhung above and behind by the hemispheres of the cerebellum, and gives origin to a number of important nerves. It is closely invested by the pia mater, which is here dense and strong, and should be dissected off carefully from one side in order to expose the subdivisions of the organ.

The anterior and posterior surfaces of the medulla oblongata are marked by continuations of the anterior and posterior longitudinal fissures (Figs. 188 and 189) of the spinal cord, by which the organ is divided into two lateral halves or columns. Each lateral half is subdivided by shallow longitudinal furrows into four small prominences, named respectively from before backward, the anterior pyramid, olivary and restiform bodies, and posterior pyramid.

The **Anterior Pyramid** (Fig. 188) is a small semicylindrical, columnar mass of medullary fibres, forming the anterior division of the

lateral half of the medulla oblongata. It is about an inch in length, prominent, and defined above by the lower margin of the bridge of Varolius, from which point it gradually subsides to its lower termination upon the general surface of the spinal cord. It is separated from its fellow of the opposite side by the anterior spinal fissure, but, upon gently pressing the two asunder, it will be noticed that, about three-fourths of an inch below the bridge, there is an interchange or decussation of fibres, several small bundles crossing the fissure obliquely from one side to the other. The anterior pyramids consist of the lateral fibres of the spinal cord, which curve forward and are continued on behind the bridge to constitute a part of the peduncles or crura of the cerebrum (Fig. 190, $_{6,3}$).

Fig. 189.

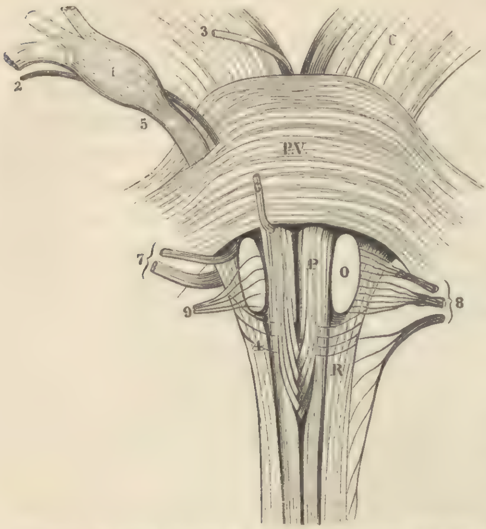


Diagram of front surface of medulla oblongata. P.V., Varolian bridge; P., anterior pyramid; O., olivary body; R., restiform body. 1, Gasserian ganglion; 2, motor root of trifacial nerve; 3, third nerve; 4, arciform fibres; 5, sensory root of trifacial nerve; 6, sixth nerve; 7, facial and auditory nerves; 8, glossopharyngeal, pneumogastric, and spinal accessory nerves; 9, hypoglossal nerve.

The **Olivary Body** (Fig. 189) is external to the anterior pyramid, from which it is separated by an indistinct furrow. It is quite prominent, regularly convex, of a well-defined ovoidal outline, and about half an inch in length; it is composed of medullary substance inclosing a small irregular mass of gray substance called the *dentated body* (Fig. 190, $_7$). Its medullary portion consists of fibres from the anterior tract of the spinal cord, which pass up through the deep strata of the pons, and then divide into two bundles; one of these, called the fillet of Reil,[12] mounts over the superior peduncle of the cerebellum to the quadrigeminal bodies, beneath which it meets with the corresponding fillet of the opposite side; the other proceeds with the anterior pyramid to form part of the corresponding peduncle of the cerebrum.* Upon the surface of the longitudinal fibres, and covering the lower extremity of the body, are a few commissural fibres, which seem to originate from the anterior pyramid, and,

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* Holden, Manual of Anatomy.

curving backward in the form of arches with their concavities presenting upward, terminate in the restiform body. They are named the *arciform fibres* (Fig. 189, 4), and are not always sufficiently well developed to be seen with the unassisted eye.

The **Restiform Body** is a round, cordlike band of medullary fibres, situated behind the olivary body, from which it is separated by a well-defined fissure, called the *respiratory tract* of Bell. It is composed of continuations of the posterior fibres of the spinal cord, ascends forward and outward, and divides into two bundles; the larger division curves outward and backward into the hemisphere of the cerebellum, forming its inferior peduncle; the smaller continues upward along the floor of the fourth ventricle and enters the cerebrum upon the posterior surface of its peduncle (Fig. 190).

Fig. 190.

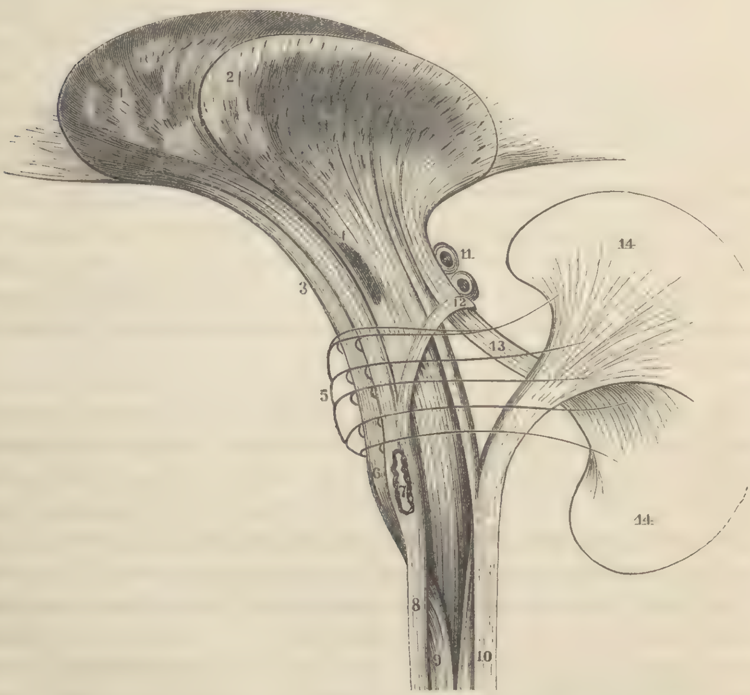


Diagram of course of fibres of cord. 1, striated body; 2, optic bed; 3, peduncle of cerebrum; 4, gray substance of peduncle; 5, Varolian bridge; 6, anterior pyramid; 7, olivary body; 8, anterior column of cord; 9, lateral column of cord; 10, posterior column of cord; 11, quadrigeminal body; 12, fillet of Reil; 13, superior peduncle of cerebellum; 14, cerebellum.

The **Posterior Pyramid** (Fig. 188) is a long narrow bundle, situated behind and upon the inner side of the restiform body. It is derived from the posterior fibres of the spinal cord, and diverges from its opposite

fellow at the lower angle of the fourth ventricle to enter the corresponding inferior peduncle of the cerebellum.

Besides the structures just described, the medulla oblongata contains a central column of gray substance, continuous with that of the spinal cord, and having the same general characters. As seen upon a transverse section, it presents the form of two lateral crescents united by their convexities in the median line (see Spinal Cord).

ORIGINS OF THE CRANIAL NERVES.

The Nerves originating from the base of the brain were considered by the older anatomists as divisible into nine pairs, which were named numerically, first, second, third, etc., commencing with the most anterior; and, although it has been long known that instead of nine there are twelve pairs, the old enumeration has become so fixed by common usage that it cannot be entirely discarded. In addition to the numerical designation, other names, derived in most instances from the parts to which the nerves are distributed, were also employed, and these are now more frequently used than the former. In the following table all the more common titles are exhibited, and the student is advised to make himself familiar with it before proceeding farther.

1st	pair.	The olfactory nerves.	
2d	"	The optic nerves.	
3d	"	The common motor nerves of the eyes (*motores oculorum*).	
4th	"	The pathetic (*pathetici*) or trochlear nerves (*trochleares*).	
5th	"	The trigeminal (*trigemini*) or trifacial nerves.	
6th	"	The abducent nerves (*abducentes*).	
7th	"	The auditory nerves (*portio mollis*).	7th pair of Willis.
8th	"	The facial nerves (*portio dura*).	
9th	"	The glossopharyngeal nerves.	8th pair of Willis.
10th	"	The pneumogastric nerves (*par vagum*).	
11th	"	The spinal accessory nerves.	
12th	"	The hypoglossal nerves.	9th pair of Willis.

This division into twelve pairs of cranial nerves is the one here adopted, in preference to the older classification into nine.

Of these twelve pairs, the following physiological classification has been made:

1. Nerves of Special Sense	1st Olfactory. 2d Optic. 7th Auditory.
2. Nerves of Motion	3d Motor ocular. 4th Abducent. 6th Pathetic. 8th Facial. 11th Spinal accessory. 12th Hypoglossal.
3. Nerves of Sensation	9th Glossopharyngeal. 10th Pneumogastric.
4. Nerve of Motion and Sensation	5th Trifacial.

The student must not, however, for a moment suppose that all the nerves maintain throughout their entire course the physiological characters assigned to them in this classification. Some of them, indeed, after they leave the cranial cavity, receive accessory fibres from nerves of a different kind, by which their functions are materially altered. Thus, the pneumogastric nerve consists of only sensory fibres at its origin, but, as soon as it passes the jugular foramen, it receives branches from the spinal accessory and hypoglossal, which are motor, and these accessory fibres are associated with the nerve in its distribution. The same is true of the glossopharyngeal; and hence these two nerves, in the greater part of their course and in their distribution are sensory-motor, that is, they consist of both sensory and motor filaments.

Other functions have, also, been assigned to some of them, the glossopharyngeal, for example, being considered by many to be the special nerve of taste, and the spinal accessory being frequently called the vocal nerve, *par excellence*, because so intimately associated with the production of voice.

Bearing these facts in mind, the student should now proceed to an examination of the origins of the nerves under consideration, beginning with the first pair.

The Olfactory or First Pair of Nerves.—The Olfactory Nerve (Fig. 182) of each side is situated in a longitudinal depression between two convolutions, upon the under surface of the anterior lobe of the cerebrum, very near the interhemispheric fissure. It is about an inch in length, triangular prismatic in shape, bulbous at its anterior extremity, and connected, by its posterior extremity, to the anterior perforated space of the base of the cerebrum. Its origin consists of three tolerably distinct roots—an external, middle, and internal. The *external root*, the longest of the three, may be traced along the outer border of the anterior perforated space as far as the fissure of Sylvius, where its fibres become blended with the central medullary substance of the anterior lobe. The *middle root* consists mainly of gray fibres continuous with the gray substance of the perforated space. The *internal root* is derived from the medullary substance of the anterior lobe of the cerebrum upon the inner side of the perforated space.

The anterior or bulbous extremity of the nerve is small in the human subject, but very large in many of the inferior animals, in some of which it constitutes the larger part of the cerebral mass. It consists in a great measure of gray substance, through which the white fibres, that constitute the main trunk of the nerve, pass to their distribution.

The branches of the olfactory nerve are very numerous; they all originate from the under surface of the bulbous extremity, and, passing through the holes in the cribriform plate of the ethmoid bone, are distributed solely to the lining membrane of the upper part of the nose.

The Optic or Second Pair of Nerves.—The Optic Nerve (Fig. 182) is remarkable for its large size, and for the crossing or decussation of its fibres with those of its fellow of the opposite side. In the fresh brain its origin cannot be satisfactorily demonstrated, but where the organ has been well hardened, three distinct roots may be discovered; one comes from the quadrigeminal bodies, another from the external geniculate body, and the third from the optic thalamus. From these three points the fibres converge to form a flattened cord called the *optic tract*, which, winding around the outer and inferior surface of the cerebral peduncle, makes its appearance upon the base of the brain, just outside of the gray tuber, along the margin of which it passes forward and inward, to form with its opposite fellow the optic crossing or commissure.

The *commissure* or *chiasm* is situated in the middle line, in front of the gray tuber, and rests upon the olivary process of the sphenoid bone. The interchange of fibres involves only a portion of each nerve, the outermost fibres of the tract being continued on to the nerve of the same side. Additional fibres are also found along the anterior border of the commissure passing from one optic nerve to the other, and a similar set behind communicating between the optic tracts. Leaving the commissure the nerve assumes a more cylindrical form, and directs its course forward and outward toward the optic foramen through which it passes into the orbit in company with the ophthalmic artery.

Having entered the orbit, the optic nerve passes forward to the distance of half an inch, perforates the sclerotic and choroid coats of the eye, and spreads out upon the vitreous humor in the form of a delicate membrane known as the retina. It is the special nerve of the sense of sight.

The Motor Ocular or Third Pair of Nerves.—The Third or Common Motor Nerve of the Eye (Figs. 182 and 189, 3), much smaller than the preceding, originates apparently from the inner surface of the peduncle of the cerebrum, but its fibres may be traced to the collection of gray substance called the black spot (*locus niger*) found in the centre of the peduncle.

From its point of connection with the cerebral peduncle the motor ocular nerve passes forward and outward, perforates the dura mater near the posterior clinoid process of the sphenoid bone, traverses the outer wall of the cavernous sinus, and divides into two branches, which enter the orbit at the sphenoidal fissure. The superior of the two divisions is distributed to the elevator muscle of the eyelid and the superior straight muscle of the eyeball; and the inferior to the internal straight, inferior oblique, and inferior straight muscles of the eye. As its name indicates, it is purely motor in its function, and supplies all the muscles within the orbit except the superior oblique and external straight.

The Pathetic or Fourth Pair of Nerves.—The Pathetic or Trochlear Nerve (Fig. 188, $_3$) is the smallest of the cranial nerves, being not larger than ordinary sewing thread. It makes its appearance upon the base of the brain immediately outside of the cerebral peduncle, and in front of the bridge of Varolius, and upon being traced backward will be found to originate from the valve of the brain just below the quadrigeminal bodies. Starting from this point, it winds around the peduncle of the cerebrum underneath the free border of the tentorium, perforates the dura mater and outer wall of the cavernous sinus near the motor ocular, and enters the orbit through the upper angle of the sphenoidal fissure.

Having entered the orbit, the pathetic nerve passes along the upper wall of this cavity, and is distributed exclusively to the superior oblique or trochlear muscle of the eye. It is simply motor in its function.

The Trifacial or Fifth Pair of Nerves.—The Trifacial, or, as it is sometimes called, the Trigeminal Nerve, is the largest of the cranial nerves, and originates apparently from the inferior surface of the annular protuberance or bridge of Varolius. It is composed of two separate bundles, one quite small, and the other large, which are in fact two distinct roots (Fig. 189, $_{2,\,5}$), the former motor or efferent in its function, and the latter sensory or afferent. Traced through the bridge to their *real origin*, the sensory root has been followed into the restiform body of the medulla oblongata and the floor of the fourth ventricle; and the motor root to the continuation of the pyramidal tract inclosed by the bridge.

Leaving the annular protuberance, the nerve is directed forward over the superior surface of the apex of the petrous bone, the two roots lying side by side, but totally distinct from each other. Here the sensory root becomes spread out to enter the great ganglion of Gasser, beneath which the motor division continues on to its destination.

The *Gasserian ganglion*, one of the largest ganglia in the body, is situated upon the superior surface of the inner extremity of the petrous bone, beneath and tolerably closely attached to the dura mater. It is flattened from above downward, semilunar or crescentic in form, and of a dark gray color. It receives the large root of the trigeminal, together with a few filaments from the sympathetic nerve. From its convex border, which presents forward, are given off three main branches, namely, the ophthalmic, superior maxillary, and inferior maxillary nerves. The *first* of these leaves the cavity of the skull through the sphenoid fissure, and is distributed to the eye, the skin of the forehead, and the lining membrane of the nose. The *second* traverses the round foramen of the sphenoid bone, and is eventually distributed to the skin of the cheek and temple, to the palate and the teeth of the upper jaw. The *third* is joined by the motor root before mentioned, with which it passes through the oval opening of the sphenoid bone, the motor portion to be distributed principally

to the muscles of mastication, and the sensory to the teeth of the lower jaw and mucous membrane of the tongue.*

The Abducent or Sixth Pair of Nerves.—The Sixth Nerve (Fig. 189, $_6$) holds a middle place in point of size between the third and fourth. It originates from the anterior pyramid, immediately beneath the posterior margin of the Varolian bridge, from which it receives a few additional fibres, passes directly forward between the latter and the basilar process of the occipital bone, traverses the outer wall of the cavernous sinus, enters the orbit through the sphenoidal fissure and between the two heads of the external straight muscle of the eye, to which it is solely distributed. Its function is strictly motory.

The Auditory or Seventh Pair of Nerves.—The Auditory Nerve (Fig. 188, $_6$) lies just external to the sixth, and in close contact with the eighth, and with the lower margin of the Varolian bridge. It originates from the floor of the fourth ventricle by numerous delicate fibres, which converge from the sides of the median fissure toward the outer angle of the cavity ; here the fibres become collected into a bundle, which winds around and receives filaments from the upper extremity of the restiform body, and, meeting the facial nerve just below the margin of the Varolian bridge, is continued along with it, a small arterial twig intervening, to the internal auditory meatus upon the posterior face of the petrous bone. Within the meatus it leaves the facial, and, dividing into two branches, is distributed upon the parts concerned in hearing. The seventh is the special nerve of the sense of hearing.

The Facial or Eighth Pair of Nerves.—The Facial Nerve (Fig. 189, $_7$), smaller than the preceding, originates from the upper extremity of the groove between the olivary and restiform bodies, with both of which its fibres are said to be connected. From this point it is directed forward by the side of the auditory nerve to the internal auditory meatus, whence it descends through the stylo-mastoid foramen to reach the muscles of the side of the face. In its course, it sends off numerous branches hereafter to be described. It belongs to the class of motor nerves.

The Glossopharyngeal or Ninth Pair of Nerves.—The Glossopharyngeal Nerve (Fig. 189, $_8$) originates from the restiform body just below the facial by two or three delicate roots. Directed horizontally outward, it traverses the jugular foramen along with the pneumogastric and spinal accessory, descends forward, being situated deep in the upper part of the neck, and is distributed to the mucous membrane and muscles of the

* A detailed account of the distribution of the fifth pair of nerves may be found upon a subsequent page

pharynx and base of the tongue. It is entirely sensory at its origin, but subsequently receives an accession of motor fibres.

The Pneumogastric or Tenth Pair of Nerves.—The Pneumogastric Nerve (Fig. 189, $_8$), so called from its furnishing branches to the lungs and stomach, originates below the preceding, by ten or fifteen small roots, from the bottom of the groove separating the olivary and restiform bodies, most of the fibres coming from the latter organ. These rootlets are directed outward, and converge toward the jugular foramen, through which they leave the cranium in the form of a flattened cord. It occupies the same sheath with the spinal accessory, and is separated from the glossopharyngeal by a small process of the dura mater. Having emerged at the base of the skull, it descends the side of the neck in the common sheath of the internal and primitive carotid arteries and jugular vein into the thorax, through which it reaches the abdomen, and distributes branches to the pharynx, larynx, trachea, lungs, heart, stomach, and several other parts, as will be hereafter seen.

The pneumogastric is composed originally of only sensory fibres, but is subsequently joined by filaments from the spinal accessory, and hypoglossal, which are motory.

The Spinal Accessory or Eleventh Pair of Nerves.—The Spinal Accessory Nerve (Fig. 189, $_8$) is enumerated with the cranial nerves, but originates from the spinal cord, as low as the third or fourth cervical vertebra. Its origin consists of a series of delicate roots coming from the lateral part of the cord, just in front of the posterior roots of the spinal nerves; these bend forward and unite to form a medium-sized bundle, which enters the cavity of the cranium through the occipito-spinal foramen, and then turns outward toward the jugular foramen, where it becomes placed in the same sheath with the pneumogastric. Leaving the skull through this opening, it is directed outward and backward to supply some of the muscles on the side of the neck. It belongs to the simple motor class of nerves.

The Hypoglossal or Twelfth Pair of Nerves.—The Hypoglossal Nerve (Fig. 189, $_9$) arises by six or eight slender filaments from the groove separating the pyramidal and olivary bodies, and is therefore upon a plane anterior to the ninth, tenth, and eleventh, and in a line with the anterior or motor roots of the spinal nerves. From its origin it is directed outward and forward, and leaves the cranium, through the anterior condyloid foramen, to be distributed to the muscles of the tongue. Its function is simply motory.

MUSCLES OF THE FACE.

One side of the face may be devoted exclusively to the dissection of the muscles, and the other to that of the vessels and nerves.

The Muscles of the Face are divisible into two distinct layers, a superficial and deep. The Superficial Muscles are arranged in four groups: 1, muscles of the eyelids and eyebrows; 2, muscles of the nose; 3, muscles of the lips and cheeks; and 4, muscles of the external ear. They are remarkable for their pale color, the softness of their texture, and the admixture of adipose tissue with their fibres. With few exceptions they are all attached by one extremity to the bones, and by the other to the soft parts around the openings to which they belong. The Deep Muscles are inservient to mastication, and are therefore all attached to the lower jaw.

The superficial muscles should be dissected first.

Dissection.—Fill the mouth with curled hair or some other elastic material, and sew the lips together; then make an incision along the median line, involving only the skin from the top of the forehead to the point of the chin, and from the middle and two extremities of this make three others, the superior extending to a level with the top of the ear, the middle to the external auditory meatus, and the inferior along the base of the lower jaw to its angle. Dissect off the superior flap first, and next the lower, taking particular care to keep the edge of the knife as close to the under surface of the skin as possible, to avoid cutting the muscles with which it is intimately connected. Next, remove the adipose substance with the knife or forceps, or both, as is most convenient.

MUSCLES OF THE EYELIDS AND EYEBROWS.

The **Palpebral Orbicular Muscle** (*orbicularis palpebrarum*, Fig. 191, $_6$) is a true sphincter, and consists of a broad thin plane of muscular fibres surrounding the base of the orbit and extending into the eyelids.

It is transversely oval in shape, and continuous at its internal extremity with a small fibrous cord called the *ocular tendon* (tendo oculi), which arises from the ascending process of the superior maxillary bone, passes nearly horizontally outward, and at the internal angle of the eyelids bifurcates to be inserted into their tarsal cartilages. The muscular fibres may be considered as taking their origin from the upper edge of this tendon, and from the internal angular process of the frontal bone. Thence they proceed in a curved manner across the upper eyelid, the adjacent part of the frontal bone, and anterior edge of the temporal aponeurosis, nearly as far as the middle of the temple, where, turning upon themselves, they curve inward in front of the malar and superior maxillary bone, and across the lower lid, to be inserted into the lower edge of the ocular tendon and inner third of the inferior margin of the orbit. The muscle is covered only by the skin, and is remarkable for being very pale and indistinct where it crosses the eyelids.

The ocular tendon lies directly in front of the upper portion of the lachrymal sac, and, being readily felt through the skin, is the guide to the surgeon when it becomes necessary to lay open this cavity for the purpose of discharging accumulated fluid, or penetrating the nasal duct.

Use.—To close the eyelids and draw down the brow, which it does by acting from its tendinous and bony attachment as a fixed point. Only the palpebral portion is brought into action in winking.

A little offset from this muscle, called the *tarsal tensor*, will be described in connection with the lachrymal apparatus.

The **Superciliary Muscle** (*corrugator supercilii*) is a small and often indistinct muscular fasciculus, situated beneath the upper portion of the orbicular muscle and the anterior extremity of the occipito-frontal muscle, resting upon the superciliary ridge of the frontal bone. It arises from the internal angular process of the frontal bone, passes upward and outward, and is blended near the middle of the eyebrow with the fibres of the muscles by which it is covered.

Use.—to draw the eyebrow toward the root of the nose, as in frowning.

The **Palpebral Elevator** (*levator palpebræ superioris*), although belonging to the group of muscles now under consideration, is situated within the orbit and cannot at present be seen.

MUSCLES OF THE NOSE.

The **Nasal Pyramidal** (*pyramidalis nasi*, Fig. 191, $_3$) is a long thin triangular strip of muscle continued down from the occipito-frontal upon the side of the bridge of the nose, where it spreads out into a delicate aponeurosis and is inserted into the skin in this situation.

Use.—To elevate the skin upon the side of the nose, or to draw down the inner extremity of the eyebrow, according as it acts from below or above.

The **Naso-labial Elevator** (*levator labii superioris alæque nasi*, Fig. 191, $_7$), small and indistinctly defined, arises by a narrow extremity from the nasal process of the upper jaw, and the adjacent part of the lower edge of the orbit; descends, widens out, and is inserted into the side of the nostril and upper lip.

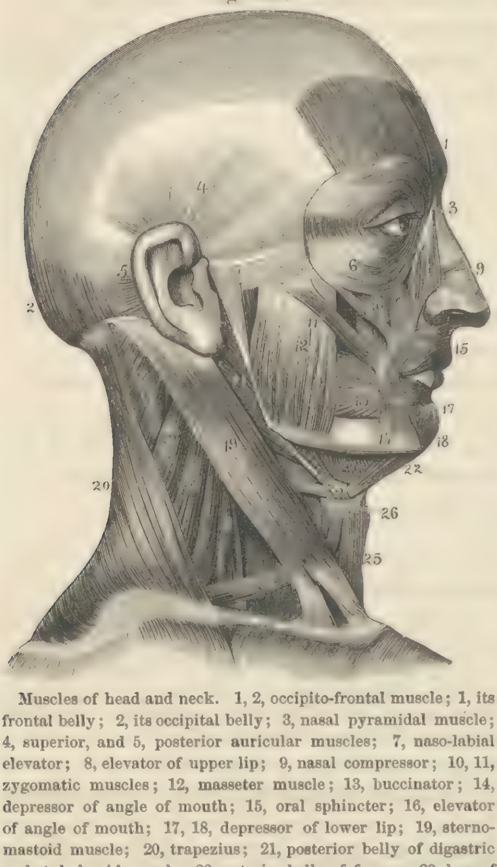
Use.—To elevate the lip and dilate the nostril.

The **Nasal Compressor** (*compressor nasi*, Fig. 191, $_9$) lies partly under the preceding, and is very thin, small, and triangular. It originates by a narrow extremity from the canine fossa, spreads out over the side of the nostril, and is inserted by a thin aponeurosis into the middle line of the cartilage of the nose. Its name indicates its use.

MUSCLES OF THE MOUTH.

The **Oral Sphincter** (*orbicularis oris*, Fig. 191, 15) consists of two curved planes of muscular fibres situated in the upper and lower lips, their extremities decussating with each other and with the muscles inserted into them. Considered as a single muscle it is elliptical in shape, its lesser circumference corresponding to the opening of the mouth, and its outer being blended with attachments of the surrounding muscles.

Fig. 191.



Muscles of head and neck. 1, 2, occipito-frontal muscle; 1, its frontal belly; 2, its occipital belly; 3, nasal pyramidal muscle; 4, superior, and 5, posterior auricular muscles; 7, naso-labial elevator; 8, elevator of upper lip; 9, nasal compressor; 10, 11, zygomatic muscles; 12, masseter muscle; 13, buccinator; 14, depressor of angle of mouth; 15, oral sphincter; 16, elevator of angle of mouth; 17, 18, depressor of lower lip; 19, sterno-mastoid muscle; 20, trapezius; 21, posterior belly of digastric and stylo-hyoid muscle; 22, anterior belly of former; 23, loop of fibrous tissue attaching tendon of digastric muscle to hyoid bone; 24, omo-hyoid muscle; 25, sterno-hyoid; 26, sterno-thyroid, seen to outer side and behind anterior belly of omo-hyoid; 27, mylo-hyoid; 28, splenius; 29, elevator of scapula; 30, 31, middle and anterior scalene muscles; 32, clavicle.

Use.—This muscle approximates the lips, and is the antagonist of all the other muscles of the mouth.

The **Large Zygomatic** (*zygomaticus major*, Fig. 191, 10), long and cylindrical, arises from the lower part of the malar bone externally to the preceding, descends forward and inward, and is inserted into the angle of the mouth. It is partly covered above by the orbicular muscle of the eye, and lies upon the buccinator and masseter.

The **Small Zygomatic** (*zygomaticus minor*, Fig. 191, 11), when present, which is by no means always the case, is a slender muscular bundle, arising from the upper part of the malar bone, and inserted into the upper lip near its angle.

The **Elevator of the Upper Lip** (*levator labii superioris*, Fig. 191, 8), broad, thin, and quadrangular, arises from the inner half of the lower margin of the orbit, and is inserted into the upper lip at a little distance from the angle. It is covered above by the palpebral orbicular muscle, and a

large quantity of fat, and covers the branches of the infraorbital vessels and nerves as they emerge at the infraorbital foramen.

The **Depressor of the Upper Lip** (*depressor labii superioris alæque nasi*), very small, may be seen by everting the lip and removing the mucous membrane by the side of the frænum. It arises from the myrtiform fossa above the incisor and canine teeth, ascends, and is inserted into the skin of the upper lip and cartilage of the nose. It is covered by the elevator and sphincter muscles.

The **Depressor of the Angle of the Mouth** (*triangularis oris*, Fig. 191, $_{14}$), flat and triangular, arises broad from the lower border and oblique line of the inferior maxillary, and, becoming narrow as it ascends, is inserted into the angle of the mouth, blending with the fibres of the sphincter muscle.

The **Depressor of the Lower Lip** (*quadratus menti*, Fig. 191, $_{17}$) is quadrilateral, and situated upon the inner side of the preceding. It arises from the lower jaw just above its base near the symphysis, ascends, its innermost fibres decussating with those of the opposite side, and is inserted into the lateral half of the lower lip. It is covered only by the skin, and lies upon the sphincter muscle, and the mental vessels and nerves.

The **Elevator of the Lower Lip** (*levator labii inferioris*) is small and conoidal, and may be seen by everting the lip and removing the mucous membrane near the frænum. It arises from the alveolar processes of the incisor teeth by a pointed extremity, and, becoming expanded as it descends, is inserted into the skin of the chin.

The use of the preceding muscles is sufficiently expressed by their names.

The **Buccinator** (Fig. 191, $_{13}$) is a broad, thin, irregularly quadrilateral muscle, situated in the cheek. Its superior margin is attached along the alveolar arch of the upper jaw, as far forward as the first molar tooth; its inferior to the corresponding part of the lower jaw, and its posterior or external to the intermaxillary ligament.* From these points the fibres pass horizontally forward, and are inserted into the oral sphincter at the angle of the mouth; just before reaching their insertion a decussation takes place, the uppermost fibres turn downward to the lower lip, and the lowermost upward to the superior, the former being apparently continuous with the inferior plane of the orbicular muscle, and the latter with the superior. It is overlapped behind by the masseter muscle and ramus of

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* This is a well-defined tendinous arch, stretched from the pterygoid process of the sphenoid to the coronoid process of the inferior maxillary.

the lower jaw, and more anteriorly by the two zygomatic muscles. It is lined internally by the mucous membrane of the mouth, and is perforated behind by the duct of the parotid gland.

Use.—To draw the angles of the mouth outward, but more particularly to contract the cavity of the mouth when the cheeks are expanded; it is, therefore, the principal muscle concerned in blowing. It also assists very materially in pressing the food from one part of the mouth to the other, and particularly in dislodging it from between the gums and cheek.

MUSCLES OF THE EXTERNAL EAR.

The Auricle or Pinna of the Ear is provided with five small muscles, scarcely worthy of mention, which extend from one part of the cartilage to another, and of three larger ones, the superior, anterior, and posterior auricular, which connect it with the surrounding parts. Only the latter are seen in this dissection.

The size of these muscles varies very greatly in different individuals; they are at best only rudimentary vestiges of muscles well marked in some of the inferior animals, by which they move the ear upward, forward, and backward.

The **Superior Auricular** (*attollens aurem*, Fig. 191, $_4$), broad, thin, and triangular, originates by its expanded extremity from the lower border of the tendon of the occipito-frontal, descends, its fibres converging, and is inserted by a pointed extremity into the back of the antihelix. It lies upon the temporal aponeurosis and is covered only by the skin.

The **Anterior Auricular** (*attrahens aurem*), situated in front of the ear, but less distinct than the preceding, arises from the temporal aponeurosis, upon which it rests, and is inserted into the helix.

The **Posterior Auricular** (*retrahens aurem*, Fig. 191, $_5$), situated behind the ear, arises from the mastoid process and is inserted into the back of the concha.

MUSCLES OF MASTICATION.

The Muscles of Mastication, unlike the preceding, are thick, firm, well defined, and of a bright-red color. They are four in number, and are all inserted into the lower jaw.

The **Masseter Muscle** (Fig. 191, $_{12}$) is short, thick, quadrilateral, and situated upon the outer surface of the ramus of the lower jaw. It originates by fleshy and short tendinous fibres from the lower edge of the zygomatic arch, and is inserted into the rough surface upon the outer aspect of the angle of the lower jaw. The superficial fibres incline a

little backward, but the deep-seated are nearly vertical, as may be readily seen by dissecting off the former.

Relations.—It is overlapped behind by the parotid gland, and above by the larger zygomatic muscle, and is crossed transversely by the duct of the parotid gland, the transverse artery of the face, and the branches of the facial nerve.

Use.—The superficial portion of the muscle elevates the lower jaw, and throws it somewhat forward; the deep-seated draws it directly upward, and, when the muscle of only one side is brought into action, the jaw is carried slightly to the corresponding side, producing a kind of grinding motion.

Dissection.—Remove the skin from the side of the head above the zygoma, and the temporal aponeurosis will be brought into view.

The *Temporal Aponeurosis* or *Fascia* is a dense, strong, fibrous membrane, covering in the temporal muscle, and attached above to the temporal ridge upon the side of the cranium, and, below, to the superior margin of the zygomatic arch and the posterior border of the malar bone. Along its lower attachment it is divided into two laminæ, inclosing a small quantity of adipose tissue and a few small bloodvessels. It is overlapped above by the tendinous expansion of the occipito-frontal muscle, crossed by the superficial temporal vessels and nerves, and has resting upon it the superior and anterior auricular muscles. Its internal surface is in contact with the temporal muscle, and gives origin above to many of its fibres.

Dissection.—Dissect off the aponeurosis, cutting close to its under surface, and detach the superior extremity of the masseter, and the temporal muscle will be almost entirely brought into view; in order properly to expose its lower portions, the zygoma must be removed.

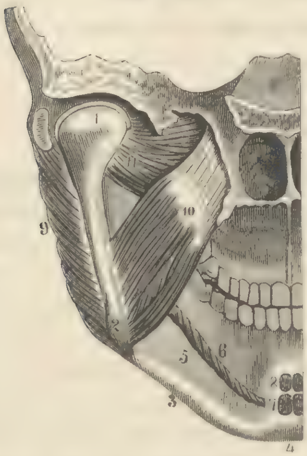
The **Temporal Muscle**, large, flat, and fan-shaped, arises from the under surface of the upper part of the temporal aponeurosis, from the semicircular ridge on the temporal and frontal bones, and from the whole surface of the temporal fossa. From these points the fibres converge downward to form a thick, fleshy mass, which, passing beneath the zygomatic arch, is inserted by strong tendinous fibres into the two surfaces and edges of the coronoid process of the lower jaw. It is covered by the temporal fascia, zygoma, and upper extremity of the masseter muscle; internally, it is in relation above with the temporal fossa, and below with the external pterygoid muscle, internal maxillary artery, and deep temporal vessels.

Use.—Simply to elevate the lower jaw.

Dissection.—Remove the temporal and masseter muscles, and saw out the zygoma, coronoid process, and anterior two-thirds of the ramus of the lower jaw, and a view of the two pterygoid muscles will be obtained.

The **Internal Pterygoid Muscle** (Fig. 192, $_{10}$) is thick and irregularly triangular, and situated deep in the zygomatic fossa along the inner face of the ramus of the jaw. It arises from the inner side of the external pterygoid plate, pterygoid fossa, and pyramidal portion of the palate bone, descends obliquely backward and outward, and is inserted into the inner face of the angle of the lower jaw, and the rough surface immediately above. It is in relation, *internally*, with the tensor muscle of the palate and with the pharynx, a quantity of areolar adipose tissue intervening; and, *externally*, with the ramus of the jaw, from which it is partly separated by the dental and lingual nerves, inferior dental vessels, and internal lateral ligament of the temporo-maxillary articulation.

Fig. 192.



View of interior part of left side of face. 1, condyle of lower jaw; 2, angle of jaw; 3, base; 4, symphysis; 5, submaxillary fossa; 6, attachment of mylo-hyoid muscle to corresponding ridge; 7, origin of genio-hyoid muscles; 8, origin of genio-glossal muscles; 9, masseter muscle; 10, internal pterygoid muscle; 11, external pterygoid muscle.

Use.—To elevate the lower jaw, and, the muscle of only one side acting, to carry it toward the opposite side, producing a true grinding motion.

The **External Pterygoid Muscle** (Fig. 192, $_{11}$), situated above and externally to the preceding, is smaller and shorter than the latter, and irregularly conoidal in shape. It originates by its larger extremity from the outer face of the external pterygoid plate, from the ridge that separates the zygomatic and temporal fossæ, and from the tuberosity of the superior maxillary; from these points the fibres converge outward and backward, and are inserted into the anterior and internal parts of the neck of the lower jaw, and into the interarticular cartilage of the temporo-maxillary joint, and its inferior synovial membrane. It is in relation, externally, with the ramus of the jaw, temporal muscle, and internal maxillary artery; internally, with the internal pterygoid muscle.

Use.—To carry the jaw forward, and, only one muscle acting, to rotate it toward the opposite side; to keep the interarticular cartilage upon the surface of the condyle, and to draw the loose synovial membrane from between the two that it may not be pinched.

VESSELS AND NERVES OF THE FACE.

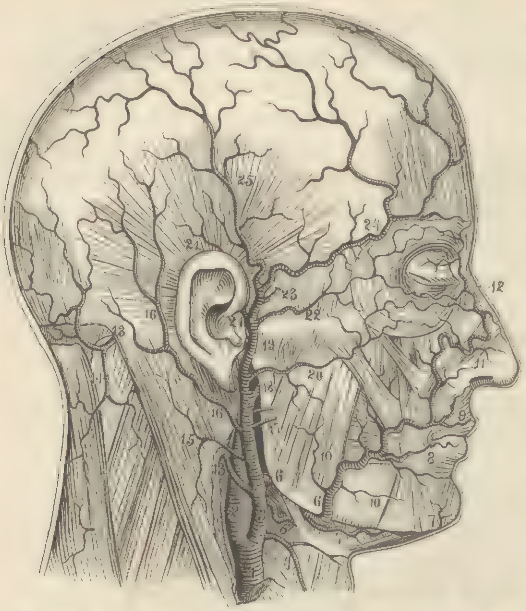
The Arteries that supply the superficial parts of the face and side of the head are the temporal, facial, supraorbital, infraorbital, and mental.

The **Temporal Artery** (Fig. 193, $_{10}$) is one of the terminal divisions of the external carotid, and is a vessel of considerable size. Commencing in the substance of the parotid gland, it ascends over the posterior root of the zygoma, about an inch and a half or two inches above which it divides into the anterior and posterior temporal branches. In the first part of its course, it is deeply seated behind the condyle of the lower jaw, but, ascending over the root of the zygoma, it becomes subcutaneous, and here its pulsations may be felt and the vessel readily compressed. In the substance of the gland it gives off several small branches to the external ear (auricular branches); and one, called the *transverse facial*, crosses the masseter muscle in company with the duct of the parotid gland, sending twigs to the gland, muscle, and superjacent skin. Just above the zygoma it sends off the *deep temporal*, which perforates the temporal aponeurosis and muscle to gain the superficial groove upon the squamous portion of the temporal bone, along which it divides into smaller twigs for the muscle and neighboring periosteum. Another branch, the *orbital*, is also sometimes given off, near this same point, to the parts above the eyebrow. The *anterior temporal*, the smaller of the two terminal divisions, ascends forward beneath the skin to the forehead, whence it bends backward to the top of the head, supplying all the adjacent parts, especially the scalp and periosteum. It is this vessel that is sometimes divided for the abstraction of blood. The largest of the branches of the anterior temporal is sometimes called the *middle temporal.* The *posterior temporal* passes tortuously upward and backward between the skin and temporal aponeurosis, and literally covers the side and top of the head with its ramifications. So freely do these two vessels anastomose with each other, with their opposite fellows, and with the supraorbital and occipital arteries, that when cut by accident or otherwise, and it becomes necessary to use the ligature, both of the cut ends have often to be secured before the bleeding can be arrested.

The **Facial** or **External Maxillary Artery** (Fig. 193, $_{6}$), also a branch of the external carotid, makes its appearance upon the face over the base of the lower jaw, just at the anterior inferior corner of the masseter muscle. From this point it ascends obliquely, in a remarkably tortuous manner, toward the inner angle of the eye, sending off branches to the lips, side of the nose, buccinator, masseter, and orbicular muscles, and to the superjacent skin. The two branches to the lips are denominated

the *superior* and *inferior coronary* or *labial;* they are the largest of the divisions, and ramify in a zigzag manner, anastomosing freely with their opposite fellows. The superior furnishes a branch to the septum of the nose. Arrived near the inner canthus of the eye, the main trunk of the artery, very much reduced in size, terminates by anastomosing with the infraorbital and supraorbital arteries.

Fig. 193.



External carotid artery and its branches. 1, right common carotid; 2, internal carotid; 3, external carotid; 4, superior thyroid; 5, lingual; 6, facial; 7, submental; 8, inferior coronary; 9, superior coronary; 10, muscular branches; 11, lateral nasal artery; 12, angular artery; 13, occipital artery; 14, descending cervical; 15, muscular branch; 16, posterior auricular artery; 17, parotid branches; 18, internal maxillary; 19, temporal; 20, transverse facial; 21, anterior auricular; 22, supraorbital; 23, middle temporal; 24, anterior temporal; 25, posterior temporal artery.

The facial and temporal arteries are accompanied each by a single vein, terminating in the jugular, as will be elsewhere described.

The Supraorbital Artery (Fig. 193, 22), the terminal division of the ophthalmic, emerges at the supraorbital notch, and immediately divides into a great number of twigs, that are distributed to the eyelid, orbicular and occipito-frontal muscles, anastomosing with the anterior temporal.

The Infraorbital Artery, a branch of the internal maxillary, and, like the preceding, of small size, makes its appearance at the infraorbital foramen, having traversed the groove and canal in company with the nerve of the same name, and divides into numerous small palpebral, muscular, periosteal, alveolar, and cutaneous twigs, which anastomose with the facial and transverse arteries upon the front of the upper jaw.

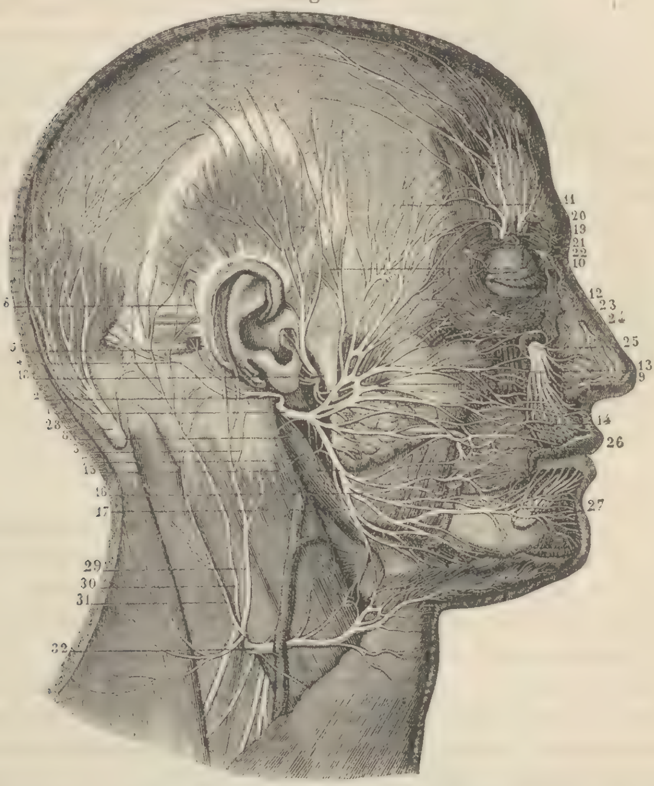
The deep parts of the face are supplied by the Internal Maxillary Artery, which, however, is more conveniently dissected in connection with the cervical branches of the external carotid.

The Nerves of the exterior of the face are branches of the facial and the fifth or trifacial. The former make their appearance from behind the

masseter muscle just below the ear, and the latter from the supraorbital, infraorbital, and mental foramina. A previous examination of Fig. 194, showing their position, will aid the student in making the proper dissections.

Dissection.—The skin should be carefully removed. as upon the other side, and the main branches of the nerves sought for and traced to their small subdivisions.

Fig. 194.



Facial nerve. 1, trunk of nerve emerging at stylo-mastoid foramen; 2, its deep auricular branch; 3, anastomosis of latter with great auricular nerve of cervical plexus; 4, 5, 6, branches to contiguous muscles; 7, 8, branches of facial to digastric and stylo-hyoid muscles; 9, temporo-facial division of facial nerve; 10, branch to temple, anastomosing with auriculo-temporal nerve; 11, temporal branches; 12, zygomatic branches; 13, infraorbital branches; 14, 15, cervico-facial division of facial nerve; 14, buccal branches; 16, inferior maxillary branches; 17, cervical branches; 18, auriculo-temporal nerve; 19, 20, terminal branches of frontal nerve; 21, terminal branch of lachrymal nerve; 22, external nasal nerve; 23, branch of temporo-malar nerve; 24, terminal branch of internal nasal nerve; 25, infraorbital nerves; 26, anastomosis between buccal branch of inferior maxillary nerve and buccal branches of facial nerve; 27, terminal branches of inferior dental nerve; 28, great occipital nerve; 29, 31, branches of great auricular nerve; 30, small occipital nerve; 32, superficial cervical nerve, anastomosing with facial nerve.

The **Facial Nerve** (Fig. 194) leaves the cranial cavity through the internal auditory foramen, and, emerging at the stylo-mastoid foramen, bends forward over the external carotid artery, and passes through the

parotid gland to the side of the face. Before reaching the latter situation it gives off quite a number of important branches, which need not be mentioned here, and in the substance of the parotid divides into two main portions, a superior or temporo-facial, and an inferior or cervico-facial.

The *Temporo-facial*, the larger of the two, arches upward and forward, and divides into three sets of branches; one set crosses over the zygomatic arch to be distributed to the temporal and occipito-frontal muscles; another spreads out upon the forehead, supplying the superciliary and parts of the orbicular and occipito-frontal muscles; and a third, formed by the subdivision of one or two considerable branches that cross the masseter muscle in company with the duct of the parotid gland, is distributed to the lower half of the orbicular muscle of the eye, the muscles of the nose and of the upper lip, forming a beautiful plexus with the infraorbital branches of the fifth pair.

The *Cervico-facial* divides into three or four branches just as it leaves the parotid gland, which, crossing the lower part of the masseter muscle, are distributed to the muscles of the lower part of the face, a few filaments (cervical branches) descending to the upper part of the neck.

The Facial Branches of the Fifth or Trifacial Nerve are the supraorbital, infraorbital, and mental, and should be sought for where they emerge from their respective foramina (Fig. 194), and carefully dissected to their small subdivisions.

The *Supraorbital* or Frontal Nerve,[19 20] derived from the first branch of the fifth, is double, one main trunk traversing the supraorbital notch, and the other passing over the margin of the orbit near its middle. From these two trunks branches are distributed to the upper eyelid, and to the skin and periosteum of the forehead and top of the head.

The *Infraorbital*[25] is the terminal branch of the second or superior maxillary division of the fifth. It emerges at the infraorbital foramen, and immediately expands into a great number of filaments, a few of which ascend to the skin and mucous membrane of the lower eyelid, but most of them descend divergingly to the skin of the side of the nose and upper lip, forming a beautiful plexus with the branches of the facial.

The *Mental Nerve*[27] is derived from the inferior dental, which is one of the main divisions of the inferior maxillary or third branch of the fifth pair. It makes its appearance at the mental foramen, and immediately divides into diverging filaments that are distributed to the skin and mucous membrane of the lower lip.

MUSCLES OF THE NECK.

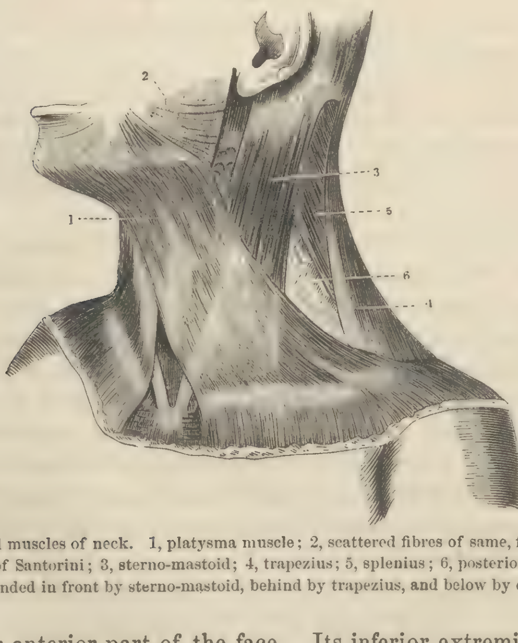
One side of the neck should be dissected with special reference to the muscles, and the other to the vessels and nerves.

Dissection.—For this dissection the left side of the neck is preferable, and, in order to place the subject in the most convenient position, draw the head to the end of the table, place a block under the shoulders, so as to put the neck on the stretch, turn the face a little to the right side, and fasten it in this position by means of hooks. Next, carry an incision along the median line, from the under part of the chin to the top of the sternum; another from the latter point along the anterior margin of the clavicle to within an inch or two of the acromion; and a third (if this has not already been made in the dissection of the face) along the base of the lower jaw, and immediately beneath the ear to the mastoid process of the temporal bone. This done, let the student examine the annexed figure in order to ascertain the position of the first muscle to be encountered, namely, the platysma; and then, placing himself at the end of the table, commence at the lower anterior angle of the flap, and turn it entirely back, carrying the cutting edge of the scalpel close to the under surface of the skin, and in the direction of the fibres of the above-mentioned muscle. If the dissection is performed very close, a thin fascia will be left upon the surface of the muscle, but in general it is better to remove this along with the skin.

MUSCLES OF THE INFRAHYOID REGION.

The **Platysma Muscle** (*platysma myöides*, Fig. 195, 1, 2), the only strictly cutaneous muscle in the human body, is a large, thin, quadrangular layer of pale fleshy fibres, situated upon the side of the neck, and extending obliquely from over the shoulder and upper part of the thorax

Fig. 195.



Superficial muscles of neck. 1, platysma muscle; 2, scattered fibres of same, forming laughing muscle of Santorini; 3, sterno-mastoid; 4, trapezius; 5, splenius; 6, posterior large triangle of neck, bounded in front by sterno-mastoid, behind by trapezius, and below by clavicle.

to the lower anterior part of the face. Its inferior extremity, commonly considered as its origin, is blended with the subcutaneous areolar tissue. Above, it is generally disposed as follows: The anterior fibres intersect

those of the opposite side, just below the chin; the middle have an imperfect attachment to the lower jaw, and the posterior are continued upon the face in front of the ear, and thence to the angle of the mouth, constituting what was formerly called the *laughing muscle of Santorini* (musculus risorius Santorini). The platysma is often but poorly developed, but never entirely wanting.

Use.—To wrinkle the skin of the neck, to assist very slightly in depressing the lower jaw, and by its posterior fibres to draw the angle of the mouth outward and upward.

Dissection.—Divide the platysma along the base of the jaw and turn it downward, taking care not to disturb the subjacent fascia.

The *Superficial Layer of the Cervical Fascia* covers the whole of the anterior and lateral regions of the neck, extending from the lower jaw and mastoid process above, to the sternum and clavicle below, and from the median line in front, where it forms a kind of raphe, to the nape of the neck behind. Superiorly, and more especially behind the angle of the jaw, it is very thick and strong. It unites with the deep layer to form sheaths for the several subjacent cervical muscles, and from the lower part of the neck may be traced over the clavicle to become continuous with the superficial fascia of the thorax.

Dissection.—Commence at the median line and turn the superficial fascia back in one continuous layer, so as to expose the sterno-hyoid and sterno-mastoid muscles. In doing this a small vein, called the *external jugular*, will be observed extending from beneath the angle of the lower jaw to the lower part of the neck, behind the middle of the clavicle, crossing the sterno-mastoid muscle. The ascending cervical nerves will also be seen upon the surface of the muscle above; but, as they will be more particularly noticed in the dissection of the other side of the neck, they may be here removed with the fascia.

The **Sterno-mastoid Muscle*** (Fig. 191, $_{19}$), the longest and largest muscle of the anterior and lateral cervical regions, extends obliquely across the neck from below and in front, upward and backward, to the side of the head behind the ear. It arises from the anterior edge of the upper extremity of the sternum, where it almost touches its fellow of the opposite side, and from the upper edge of the sternal third of the clavicle, and is inserted into the outer surface of the mastoid process of the temporal bone and the adjacent third of the superior semicircular line of the occiput. Its lower extremity or origin consists of a separate clavicular and a sternal head or slip, the former composed of fleshy and tendinous fibres spread along the clavicle to a variable extent, and the latter of a well-defined flat tendon. The two divisions ascend, the clavicular portion almost vertically, and the sternal obliquely backward, and unite generally

* So called, for the sake of abbreviation, though, from its points of origin, very frequently referred to as the "sterno-cleido-mastoid."

about two or three inches above their origin, but not unfrequently remain separate for a much longer distance, although lying side by side, and held together by areolar tissue. The variable extent to which the clavicular portion is attached along the clavicle in different individuals, occupying, as it sometimes does, nearly one-half, and in others not more than one-fourth of the length of the bone, is a fact of no little interest in reference to the operation of ligating the subclavian artery.

Relations.—The sterno-mastoid is covered by the superficial layer of the cervical fascia, which, as before mentioned, is exceedingly dense and firm above; it is crossed by the external jugular vein, and by the ascending branches of the cervical plexus of nerves and platysma muscle. Its deep relations are numerous, and will be hereafter mentioned.

Use.—To incline the head to the corresponding side, and rotate it so that the face will be turned in an opposite direction. Both muscles acting simultaneously flex the head forward, unless it has been already thrown far back, when their tendency is to increase the posterior flexion, as is seen in opisthotonos.

Dissection.—Cut the preceding muscle from the inferior attachment, and turn it upward; in doing this, the spinal accessory nerve will be seen perforating its posterior border above and descending toward the shoulder.

The *Deep Layer of the Cervical Fascia*, now almost entirely exposed, stretches across the whole breadth of the neck, and is attached above to the base of the lower jaw, and below to the posterior surface of the clavicle and upper extremity of the sternum. Besides forming the posterior layer of the sheath of the sterno-mastoid muscle, it sends processes around nearly all of the subjacent vessels, nerves, and muscles, forming so many separate envelopes or sheaths to these structures. One of the most important of these processes extends from the angle of the lower jaw to the styloid process; it is called the *stylo-maxillary ligament*, and forms a strong septum between the parotid and submaxillary glands.

The unyielding nature and close attachment of this membrane to the clavicle, spine, and lower jaw, explain the tendency that deep-seated fluid, and even solid tumors in this situation, manifest, to spread into the surrounding regions, and the difficulties that sometimes attend their diagnosis.

Dissection.—Reverse the cervical fascia from all of the subjacent parts, first in the lower and afterward in the upper part of the neck. The student should be here reminded that, unless he is willing to give sufficient time and patience to the entire removal of all the fat and cellular tissue that conceals the subjacent parts, he had better give up dissecting and turn his attention to something else; for if there is any region of the body that more than another amply repays one for the care and labor that is required for its display, it is the region of the neck.

The Muscles exposed by this dissection in the lower and anterior parts

of the neck are the sterno-hyoid, sterno-thyroid, thyro-hyoid, crico-thyroid, omo-hyoid, and anterior scalene.

The **Sterno-hyoid Muscle** (Fig. 191, 25), long and ribbonlike, arises from the posterior surface of the upper part of the sternum and cartilage of the first rib, ascends in front of the neck, and is inserted into the lower border of the hyoid bone near its middle.

Use.—To depress the hyoid bone, and with it the root of the tongue.

Relations.—It is covered by the superficial cervical fascia, crossed obliquely below by the sterno-mastoid, and lies upon the sterno-thyroid and thyro-hyoid muscles, and thyroid gland.

Dissection.—Cut the sterno-hyoid across its middle, reflect back its two ends, and dissect the cervical fascia from the two subjacent muscles.

The **Sterno-thyroid Muscle** (Fig. 191, 26), broader and shorter than the preceding, arises from the posterior surface of the upper part of the sternum and cartilage of the first rib, ascends vertically, and is inserted into the oblique ridge upon the outer surface of the thyroid cartilage.

Use.—To depress the larynx.

Relations.—It is almost entirely covered by the preceding muscle, projecting, however, beyond its outer edge. It lies directly in front of the junction of the subclavian and internal jugular veins, the trachea and thyroid gland, overlapping by its outer edge the common carotid artery, and is in contact with the internal jugular vein.

The **Thyro-hyoid Muscle**, small and quadrangular, and apparently a continuation of the preceding, arises from the oblique ridge upon the thyroid cartilage, and is inserted into the posterior surface of the body and adjacent part of the greater horn of the hyoid bone.

Use.—To approximate the thyroid cartilage and hyoid bone.

Relations.—It is covered by the sterno-hyoid muscle, and rests upon the thyroid cartilage and thyro-hyoid membrane.

The **Omo-hyoid Muscle** (Fig. 191, 24) long and slender, arises broad and fleshy from the ligament of the scapular notch and the margin of the bone immediately behind, and is inserted into the hyoid bone just outside of the insertion of the sterno-hyoid. It consists of two fleshy bellies and an intermediate tendon. The lower belly is somewhat rounded, and passes from its origin almost transversely, but inclining a little upward, across the lower part of the neck almost as far as the trachea; here a small rounded tendon is formed, inclosed by a fold or loop of the cervical fascia, beyond which the muscle becomes again fleshy and turns almost directly upward, inclining toward the median line to its insertion. The loop through which the tendon of the muscle passes is attached below to the clavicle, and acts as a pulley, the effect of which is to alter the

direction of the muscle, making its line of action downward and very little backward from the hyoid bone.

Relations.—Its origin from the scapula is concealed by the trapezius muscle and clavicle, and above the latter the lower belly is covered only by the cervical fascia, a few lymphatic glands, the platysma muscle, and the skin; above this point it is almost entirely hid by the sterno-mastoid. It crosses from behind the brachial plexus of nerves, anterior scalene muscle, phrenic nerve, the branches of the thyroid artery, internal jugular vein, common carotid artery, and pneumogastric nerve. This muscle is one of the guides to the operation for tying the subclavian artery, which vessel is situated immediately below and internal to the inferior fleshy belly.

The **Anterior Scalene Muscle** (*scalenus anticus*, Fig. 191, $_{31}$), although belonging to an entirely different group, is exposed in this dissection, and should be particularly noticed on account of its relation to the subclavian artery. It is situated deep behind the middle of the clavicle, and is somewhat conoidal in shape, with its base presenting downward; arises tendinous from the eminence upon the middle of the upper surface of the first rib, ascends a little backward, and is inserted into the anterior tubercles of the transverse processes of the lower four cervical vertebræ.

Use.—To elevate the anterior part of the thorax, aiding thus in inspiration; or, the thorax being the fixed point, to assist in bending the neck forward and a little to the same side.

Relations.—It is crossed in front at its lower extremity by the subclavian vein; near the middle, by the transverse and suprascapular arteries; and obliquely, from above downward and inward, by the phrenic or diaphragmatic nerve. Its posterior surface is covered below by the pleura, crossed about the middle by the subclavian artery, and rests above upon the large nerves that here leave the spine to form the brachial plexus. Its inner border is nearly in contact with the thyroid axis and its branches, and separated by a very narrow interval from the vertebral artery. Its outer border forms a triangular space with the lower belly of the omohyoid muscle externally and the first rib below, through which the subclavian artery and brachial plexus of nerves pass on their way to the axilla. It is in this space that the artery is usually sought for to be ligated.

Dissection.—Remove the whole of the sterno-mastoid, sterno-hyoid, sterno-thyroid, and omo-hyoid muscles, leaving the scalene in its place; and proceed to the study of the upper part of the neck. The structures that will first claim attention here are the parotid and submaxillary salivary glands. To expose the former, the very dense portion of the cervical fascia, already mentioned as existing behind the angle of the lower jaw, must be dissected off; the latter is seen beneath the base of the lower jaw, upon the removal of the platysma muscle and subjacent thin layer of fascia.

THE SALIVARY GLANDS.

The Salivary Glands are conglomerate organs; they are the parotid, submaxillary, and sublingual.* The parotid and submaxillary, having been exposed, should now be examined.

The **Parotid Gland** occupies a very irregular cavity, to the shape of which it is moulded, bounded in, in front, by the ramus of the lower jaw and stylo-maxillary ligament; behind, by the external ear, mastoid process, and upper extremity of the sterno-mastoid muscle; above, by the zygoma and back part of the glenoid cavity; internally, by the styloid process, and, below, by the digastric and stylo-hyoid muscles. The deep part of the organ is narrow and irregularly contracted; but, externally, it is expanded over the adjacent borders of the masseter and sterno-mastoid muscles. It belongs to the class of racemose or vesicular compound glands. Its color is pale pink, its appearance very rough and ragged, and it consists of numerous lobes and almost innumerable smaller lobules, held together by ducts, bloodvessels, and interlobular areolar tissue continuous with the dense fascia that invests its external surface. By the union of the several minute ducts belonging to the individual lobules one main trunk is formed, about the size of a crowquill, and named the *duct of Stenon*, which, proceeding forward from the body of the gland, just below the zygoma, crosses the masseter muscle, perforates the buccinator, and, continuing a short distance between the latter and the mucous membrane of the mouth, opens upon the inner surface of the cheek opposite the first or second upper molar tooth. Connected with the duct and resting upon the outer surface of the masseter muscle, is generally a small detached portion of the gland, called the *accessory parotid.*

The parotid gland is perforated by the external carotid, temporal, internal maxillary, and transverse facial arteries, temporal and internal maxillary veins, and facial nerve. From these vessels the proper arteries and veins of the gland are derived. This gland is sometimes the seat of disease that demands surgical interference. The difficulties attending its entire removal (and numerous such feats are recorded) may be in some degree appreciated by the student, by here attempting it himself; he will find that he has no easy task to perform, but the greater difficulties in the living subject, arising from profuse hemorrhage and the diseased condition of the parts, he need not desire to encounter.

The **Submaxillary Gland**, the second of the salivary glands in point of size, is situated beneath the middle of the body of the lower jaw, and rests upon the mylo-hyoid muscle, hypoglossal nerve, and the tendon of

* The mucous follicles of the mouth, elsewhere described, also pour out their fluid to unite with that supplied by the salivary glands proper, the combined fluid being known as saliva.

the digastric muscle. It is covered in by the cervical fascia and platysma muscle, and separated from the parotid gland by the strong inversion of the cervical fascia, called the stylo-maxillary ligament. It is of a pale pink color, oblong in shape, of an irregular surface, and grooved internally for the passage of the facial artery. Like the parotid, it is composed of lobes and smaller lobules held together by vessels, nerves, and an interlobular areolar tissue, continuous with a thin, imperfect, areolar investment derived from the cervical fascia. The excretory duct, called *Wharton's duct*, formed by the union of the smaller ducts from the elementary lobules, leaves the deep part of the gland, winds around the posterior margin of the mylo-hyoid muscle, passes along the inner side of the sublingual gland, and opens into the cavity of the mouth by a very small orifice upon the summit of the little papilla, situated by the side of the frænum of the tongue. The walls of the duct are very thin, which renders it somewhat difficult to find, but its caliber is nearly as great as that of the parotid duct.

The arteries of the gland are derived from the facial, that passes along a groove upon its deep surface.

The parotid and submaxillary are the only salivary glands revealed in this dissection; the sublingual gland will be described as associated more directly with the muscles of the suprahyoid region (p. 448).

MUSCLES OF THE SUPRAHYOID REGION.

Dissection.—Remove the submaxillary gland, make the subjacent muscles tense by means of a hook extending from over the body of the hyoid bone to the chest, and dissect off the cervical fascia.

The Muscles composing the Suprahyoid Group are the digastric, stylo-hyoid, mylo-hyoid, genio-hyoid, hyo-glossal, genio-hyo-glossal, stylo-glossal, and lingual.

The **Digastric Muscle** (Fig. 191, 21, 22, 23) consists of two conoidal fleshy bellies, and an intervening rounded tendon. It arises from a groove upon the inner side of the base of the mastoid process of the temporal bone, descends forward toward the hyoid bone, near which its tendon passes through a loop of the cervical fascia and the fleshy part of the stylo-hyoid muscle; it then ascends obliquely to be inserted into a rough depression upon the inner side of the base of the lower jaw, close to the symphysis.

Use.—To elevate the hyoid bone and the parts connected with it, or to depress the lower jaw.

Relations.—Its anterior belly is covered only by the cervical fascia platysma, and skin; but its posterior is rather deeply situated beneath the parotid gland and the insertion of the sterno-mastoid muscle. By its angular course, it forms with the base of the lower jaw a triangular

space, in which the submaxillary and parotid glands are contained, separated from each other by the stylo-maxillary ligament.

Dissection.—Detach the posterior belly of the digastric, and turn it forward.

The **Stylo-hyoid Muscle** (Fig. 191, 21), very slender, arises by a small tendon, from the styloid process of the temporal bone, descends forward, and is inserted fleshy into the body of the hyoid bone. It is perforated near its insertion by the tendon of the digastric.

Use.—To elevate the hyoid bone and its connections, carrying them at the same time backward toward the spine.

Dissection.—Detach the anterior belly of the digastric, and turn it downward.

The **Mylo-hyoid Muscle** (Fig. 191, 27), flat and triangular, forms the inner wall of the digastric fossa, and the floor of the mouth. It originates from the whole length of the mylo-hyoid ridge of the inferior maxillary bone, from which its fibres descend forward, the posterior and longer to be inserted into the body of the hyoid bone, and the anterior into the corresponding muscle of the opposite side, forming with it a median raphe or line of intersection, extending from the symphysis of the chin to the middle of the hyoid bone.

Use.—To elevate the hyoid bone and larynx; or, this bone being the fixed point, to depress the lower jaw.

Relations.—Externally it is in relation with the submaxillary gland and anterior belly of the digastric; internally, with the hypoglossal and gustatory nerves, and Whartonian duct, which separate it from the hyoglossal muscle, with the sublingual gland, mucous membrane of the mouth, and genio-hyoid muscle.

Dissection.—Detach the mylo-hyoid from the lower jaw and hyoid bone, reflect it forward, and separate it from its opposite fellow.

The **Genio-hyoid Muscle** (Fig. 196, 9), small and rounded, extends from the tubercle upon the posterior aspect of the symphysis of the lower jaw to the body of the hyoid bone. It is closely connected to its fellow of the opposite side, the anterior border of the hyo-glossal muscle, and the posterior surface of the anterior portion of the mylo-hyoid.

Use.—To elevate the hyoid bone, or depress the lower jaw.

Dissection.—Dissect the genio-hyoid from its connections.

The **Hyo-glossal Muscle** (Fig 196, 5, 6), flat and quadrangular, arises from the body and greater horn of the hyoid bone, and is inserted into the side of the under surface of the tongue near its margin.

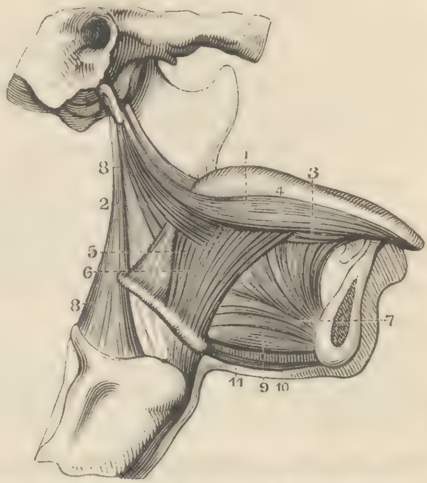
Use.—To depress the tongue, or draw it backward when protruded, and to elevate the hyoid bone.

Relations.—By its outer surface, with the gustatory and hypoglossal

nerves and duct of Wharton, which separate it from the mylo-hyoid, with the submaxillary and sublingual glands and stylo-hyoid muscle; by its deep surface, with the middle pharyngeal constrictor and genio-hyo-glossal muscles, the lingual artery lying between it and the latter.

Dissection.—Detach the hyo-glossal entirely, and draw the hyoid bone downward as far as possible.

Fig. 196.



Side view of muscles of tongue. 1, 2, stylo-glossal muscle; 3, lingual muscle; 4, upper part of tongue; 5, 6, hyo-glossal muscle; 7, genio-hyo-glossal muscle; 8, stylo-pharyngeal muscle; 9, genio-hyoid muscle; 10, 11, median line of mylo-hyoid muscles.

The **Genio-hyo-glossal Muscle** (Fig. 196, 7), broad and fan-shaped, arises from the tubercle upon the back part of the symphysis of the lower jaw, from which its fibres diverge in an antero-posterior direction to be inserted into the whole length of the under surface of the tongue, the most anterior and inferior fibres curving downward to be attached to the body of the hyoid bone.

Use.—Its inferior and middle fibres elevate the hyoid bone, or protrude the tongue, according as the jaw or hyoid bone is the fixed point; the anterior withdraw this organ when protruded.

Relations.—By its outer surface with the preceding muscle, lingual artery, and sublingual gland; internally with its fellow of the opposite side; and by its anterior margin with the genio-hyoid muscle.

The **Lingual Muscle** (*lingualis*, Fig. 196, 3) is a bundle of fleshy fibres, placed upon the inferior surface of the tongue, just outside of the insertion of the preceding, extending the whole length of the organ, and inserted into the hyoid bone.

Use.—To shorten the tongue, and bend its apex downward or to one side.

The **Stylo-glossal Muscle** (Fig. 196, 1, 2), small and slender, arises from near the extremity of the styloid process, passes forward and a little downward, spreads out, and is inserted into the side of the under surface of the tongue nearly as far as its tip, its fibres blending with those of the hyo-glossal.

Use.—To draw the tongue backward and to one side.

Relations.—It is covered externally by the parotid gland, internal

pterygoid muscle, gustatory nerve, mucous membrane, and sublingual gland; internally, it is in apposition with the stylo-hyoid ligament, tonsil, and superior constrictor muscle of the pharynx.

The **Stylo-pharyngeal Muscle**,[8] deeper seated than the preceding, but also seen in this dissection, is long and slender. It arises from the base of the styloid process, descends forward, spreads out, and is inserted into the side of the pharynx, some of its fibres reaching as far as the hyoid bone and thyroid cartilage.

Use.—To elevate and dilate the pharynx.

Relations.—It is covered by the stylo-hyoid and other muscles of this group, the external carotid artery, and parotid gland; internally, it is in contact with the internal carotid artery, jugular vein, sympathetic and pneumogastric nerves. The glosso-pharyngeal nerve passes along its outer border.

This completes the muscles of the side of the neck; but, before leaving this region, the student should examine the sublingual gland, which is already exposed by the removal of the mylo-hyoid muscle.

The **Sublingual Gland**, the smallest of the three salivary glands, is of an oval or oblong figure, and about the size of a white bean. It is situated beneath the mucous membrane of the mouth, by the side of the bridle of the tongue, resting upon the anterior part of the mylo-hyoid muscle. Its anterior extremity is very nearly in contact with its fellow of the opposite side, and along its inner border, and in close apposition, passes the duct of the submaxillary gland.

Its structure is precisely similar to that of the parotid and submaxillary, but, instead of having only one excretory duct, it has eight or ten, which open upon the floor of the mouth, by the side of the bridle of the tongue.

The student should now turn to the other (right) side of the neck, to study more particularly the vessels and nerves.

VESSELS AND NERVES OF THE NECK.

For this dissection, it is supposed that the student has reserved the right side of the neck, although an examination of both sides is to a certain extent necessary, owing to differences in the carotid and subclavian arteries presently to be mentioned.

Dissection.—The left side of the neck and both sides of the face having been already dissected, only one incision becomes necessary, namely, from the sternum along the clavicle, to within a short distance of the acromion. The skin and platysma muscle may be here removed together, care being taken to leave the external jugular vein. Next, dissect the superficial layer of the cervical fascia from the sterno-mastoid muscle, without disturbing the ascending and descending branches of the cervical plexus of nerves represented in Fig. 197.

The **External Jugular Vein** (Fig. 197), situated upon the side of the neck, is superficial to the cervical fascia and sterno-mastoid muscle, and corresponds to a line drawn from the angle of the jaw to the middle of the clavicle. It is exceedingly variable in size, but generally small; is usually formed by the union of the temporal and internal maxillary veins, and receives in its course the superficial occipital, suprascapular and posterior scapular veins, and sometimes the facial, lingual, and superior laryngeal. At its superior extremity it communicates with the internal jugular, and terminates below in the subclavian vein, by perforating the cervical fascia.

Relations.—It crosses the sterno-mastoid and omo-hyoid muscles obliquely, and is covered by the skin and platysma, the fibres of the latter crosssing it obliquely from above downward and backward.

Bleeding from this vein, an operation oftener described than practiced, at least in this country, is performed by making the incision across the direction of the fibres of the platysma, in order that by their contraction the sides of the orifice may be drawn asunder, thus promoting the flow of blood, which effect would be rather counteracted if the incision were made in an opposite direction, that is, in a line with the fibres.

The three small **Nerves** seen upon the surface of the sterno-mastoid muscle, in the neighborhood of the external jugular vein (Fig. 197), are branches of the cervical plexus. One of them, called the *superficial cervical*, makes its appearance behind the posterior margin of the muscle near its middle, ascends obliquely across its surface toward the lower jaw, beneath which it joins a branch of the facial, and is ultimately distributed to the integument in front of the neck. Another, the *large auricular*, passes from the same point vertically upward by the side of the external jugular vein, and is distributed to the external ear and the integument immediately below. The third, named the *small occipital*, ascends along the posterior border of the muscle to the skin of the occi-

Fig. 197.

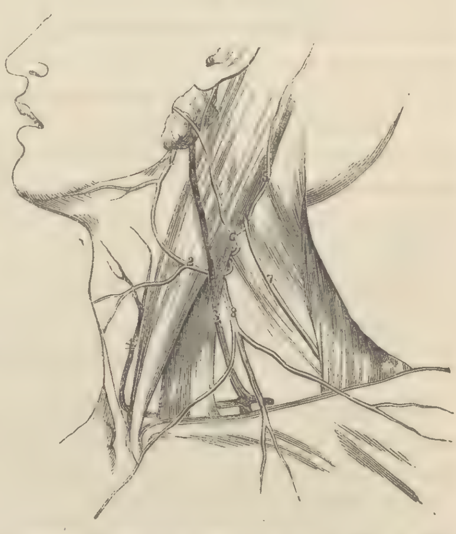


Diagram of superficial nerves and veins of neck. 1, cervical branch of facial nerves; 2, superficial cervical nerve; 3, external jugular vein; 4, anterior jugular vein; 5, small occipital nerve; 6, great auricular nerve; 7, accessory nerve; 8, descending or supraclavicular branches of cervical plexus.

put. From the cervical plexus may also be seen numerous superficial descending filaments, which perforate the cervical fascia just above the clavicle, on their way to the integument covering the upper and lateral parts of the chest.

Anterior to the sterno-mastoid muscle, and descending from beneath the lower jaw upon the sheath of the carotid artery and internal jugular vein, is the descending branch of the hypoglossal nerve, called technically the *descendens noni.* Upon the surface of the jugular vein in the lower part of the neck, it forms an anastomotic loop with a branch from the cervical plexus, and sends branches to the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles.

Dissection.—Flex the neck laterally, so as to relax the sterno-mastoid, and proceed carefully to dissect all the fascia, and the areolar and adipose tissues from the subjacent and surrounding parts. In doing this, the lymphatic ganglia or glands of this region are also necessarily removed.

The **Lymphatic Glands** of the neck (cervical glands), like those in most other parts of the body, are of a pale pink color, oval in shape, and vary in size from that of a large grain of wheat to that of a white bean. They are divided into a superficial and a deep set. The *superficial group* are found, for the most part, upon the surface of the sterno-mastoid muscle, behind this muscle, and above the outer extremity of the clavicle, and in the neighborhood of the parotid and submaxillary glands. A few are also found between the hyoid bone and thyroid cartilage, and upon the sides of the larynx. The *deep group* are more numerous, and form a continuous chain or series along the jugular vein and carotid artery, from the base of the skull to the thorax. The cervical glands receive the lymphatic vessels from the side of the head and deep parts of the neck, and are remarkable for their proneness to inflammation and tubercular deposit in persons of a strumous diathesis, and more particularly in children.

Before proceeding to the examination of the deeper vessels and nerves of the neck, the student should make himself acquainted with the regions that are marked off by the sterno-mastoid and omo-hyoid muscles.

Triangles of the Neck.—By means of the sterno-mastoid muscle the side of the neck is divided into two large triangular regions, of nearly equal size, called the anterior and posterior cervical triangles.

The *Anterior Cervical Triangle* is bounded, above, by the base of the lower jaw; in front, by the middle line of the neck; and, behind, by the anterior border of the sterno-mastoid muscle. The anterior belly of the omo-hyoid muscle crosses the lower part of this space, and thus subdivides it into a superior and inferior triangle, of which the former is much the larger.

The *inferior* subdivision, called the *omo-tracheal triangle,* is bounded, in front, by the trachea; above, by the anterior belly of the omo-hyoid

muscle; and, behind, by the lower part of the sterno-mastoid muscle. It is traversed vertically by the primitive carotid artery, jugular vein, and pneumogastric nerve.

The *superior* subdivision is bounded, in front, by the anterior belly of the omo-hyoid muscle; behind, by the upper half of the sterno-mastoid muscle; and, above, by the base of the lower jaw. It contains a number of most important structures, of which it is necessary only to enumerate the primitive carotid, internal carotid, external carotid, superior thyroid, lingual and facial arteries, and their accompanying veins, and the pneumogastric, spinal accessory, and hypoglossal nerves. It is further subdivided above by the digastric muscle, which forms with the base of the lower jaw a triangular space known as the digastric fossa, which is occupied by the submaxillary gland, and is traversed by the facial artery and vein and hypoglossal nerve.

The *Posterior Cervical Triangle* is bounded, behind, by the anterior border of the trapezius muscle; below, by the clavicle; and, in front, by the sterno-mastoid. It is subdivided by the lower belly of the omo-hyoid muscle into two smaller triangles, of which the inferior, called the omo-clavicular, is the smaller but more important.

The *omo-clavicular triangle* is bounded, in front, by the lower part of the sterno-mastoid muscle; above, by the inferior belly of the omo-hyoid; and, below, by the clavicle. In it will be found the subclavian artery and vein, brachial plexus of nerves, and transverse cervical and posterior scapular arteries.

The Arteries of the Neck may now be examined in the different regions.

The **Primitive** or **Common Carotid Artery** (Fig. 198) lies deep in the front part of the neck, by the side of the trachea, inclosed in a common sheath with the internal jugular vein and pneumogastric nerve.

This sheath, together with the descending branch of the hypoglossal nerve (descendens noni) that rests upon its surface, must be removed before the vessels can be distinctly seen. Upon the right side of the neck, the common carotid originates, behind the right sterno-clavicular articulation, from the brachio-cephalic or innominate artery, which is common to it and the subclavian of the same side; but upon the left it comes directly from the arch of the aorta, just to the left of the origin of the innominate. The left is therefore somewhat longer than the right, but both are nearly of the same size, and are placed upon nearly the same level. From its origin the vessel ascends the neck, gradually inclining backward; it gives off no collateral branches, and, opposite the upper border of the thyroid cartilage, divides into the internal and external carotid (Fig. 198, $_{2}$, $_{3}$).

Relations.—The primitive carotid is contained, as just stated, in the same sheath with the internal jugular vein and pneumogastric nerve, the former

lying external to the artery, and, when full, overlapping it; the nerve is behind and between the two. Its lower half is concealed by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, the last two lying directly upon it; and a little higher up it is crossed by the omo-hyoid muscle. Above this point to its bifurcation the vessel is situated in the triangular space formed by the sterno-mastoid, omo-hyoid, and digastric muscles; and, being here covered only by the skin and platysma, is readily found by the surgeon when a ligature is to be applied. Posteriorly, it is separated from the front of the spine by the prevertebral muscles and sympathetic nerve, and is crossed by the inferior thyroid artery.[20] Internally, it is in close relation with the trachea, œsophagus, recurrent laryngeal nerve, larynx, and thyroid gland, which last, when enlarged, frequently overlaps it in front.

Fig. 198.

Left common carotid dividing into external and internal carotid arteries. 1, common carotid artery; 2, internal carotid; 3, external carotid; 4, superior thyroid; 5, lingual; 6, pharyngeal artery; 7, facial; 8, inferior palatine and tonsillar arteries; 9, submaxillary; 10 submental; 11, occipital; 12, posterior auricular; 13, parotid branches; 14, internal maxillary; 15, temporal artery; 16, subclavian artery; 17, axillary; 18, vertebral artery; 19, thyroid axis; 20, inferior thyroid giving off ascending cervical; 21, transverse cervical; 22, suprascapular; 23, internal mammary artery.

Variations in the origins of the carotids are not very rare. The most common is that in which the left comes off from the root of the brachiocephalic or innominate artery. They have also been occasionally observed to send off collateral branches.

The **External Carotid Artery** (Fig. 198, 3) commences at the bifurcation of the primitive carotid in the superior cervical triangle, opposite the upper margin of the thyroid cartilage, and upon the inner side of the internal carotid.* At first it ascends inward, and then bends backward and a little outward in the direction of the temporo-maxillary articulation, externally to which it terminates by dividing into the temporal and internal maxillary arteries.

Relations.—In the first part of its course, it lies in the triangular space bounded by the sterno-mastoid, omo-hyoid, and digastric muscles, and is covered only by the skin and platysma muscle. A ligature is applied here with some difficulty, owing to the numerous branches that it gives off. About its middle, it lies in close relation with the pharynx; still higher up it is internal to the stylo-hyoid and posterior belly of the digastric muscle, crossed by the hypoglossal nerve, and separated from the internal carotid by the stylo-glossal and stylo-pharyngeal muscles and glosso-pharyngeal nerve. At its termination, it is imbedded in the substance of the parotid gland, and crossed by the facial nerve.

Branches.—The external carotid has ten branches, including its two terminal ones, which may be arranged as follows:

1. *Anterior branches.*—Superior thyroid, lingual, facial.
2. *Posterior branches.*—Mastoid, posterior auricular, occipital.
3. *Internal branches.*—Ascending pharyngeal, internal maxillary, temporal.

The three Anterior Branches, the Superior Thyroid, Lingual, and Facial, originate very near each other from the anterior aspect of the artery in the first part of its course, the lingual and facial often by a common trunk.

The **Superior Thyroid Artery** (Fig. 198, 4), a vessel of considerable size, arises from the external carotid, immediately above the bifurcation of the common carotid, descends forward, and is distributed to the thyroid body.

Branches.—In its course it gives off three small twigs: one, called the *hyoid*, to the sterno-hyoid and sterno-thyroid muscles; one, called the *laryngeal*, that perforates the thyro-hyoid membrane in company with the superior laryngeal nerve, to be distributed in the mucous membrane of the larynx; and a third, very small, named the *crico-thyroid*, that passes in front of and below the larynx, sending twigs through the crico-thyroid membrane to the interior of the larynx.

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* The terms internal and external, as applied to the carotids, have reference not to their location but to their distribution; the former supplying the internal, and the latter the external parts of the head.

The **Lingual Artery** (Fig. 198, $_5$) originates immediately above the preceding, frequently by a common trunk with the facial, passes inward above the greater horn of the hyoid bone, then between the hyo-glossal and genio-hyo-glossal muscles to the base of the tongue; thence, under the name of the *ranine artery*, it runs in a serpentine manner in the substance of the under part of the tongue to its tip.

Branches.—It sends off a *hyoid* twig to the elevator muscles of the larynx, a *dorsal lingual* to the mucous membrane of the superior surface of the tongue, and a *sublingual* to the sublingual gland and adjacent mucous and muscular tissues.

The **Facial Artery** (Fig. 198, $_7$), the largest of the three anterior branches of the external carotid, is given off opposite the hyoid bone. It passes upward and forward beneath the digastric and stylo-hyoid muscles, runs along a groove in the under surface of the submaxillary gland, then turns over the base of the lower jaw just in front of the attachment of the masseter muscle, and ascends in a very tortuous manner toward the internal angle of the eye. Before reaching the latter point, it is diminished to a very small twig by frequent branching.

Branches.—The cervical branches of the facial are: 1. The *inferior palatine*, often a branch of the external carotid, very small, which ascends between the stylo-glossal and stylo-pharyngeal muscles, to be distributed to the soft palate and tonsils. 2. The *submaxillary*, four or five in number, given off while the artery is in the groove beneath the submaxillary gland, and distributed to this organ. 3. The *submental*, sometimes a branch of the lingual, coming off above the preceding, and passing forward upon the surface of the mylo-hyoid muscle near its attachment to the lower jaw, to supply the muscles beneath the chin. The facial branches are the labial or coronary, and angular, which have been already described.

The Posterior Branches are the mastoid, posterior auricular and occipital.

The **Mastoid Artery** (not shown in Fig. 198) arises from the external carotid nearly opposite the lingual, descends obliquely backward, and is distributed to the sterno-mastoid muscle. It is very small and often wanting.

The **Occipital Artery** (Fig 198, $_{11}$) arises a short distance above the preceding, ascends obliquely backward beneath the posterior belly of the digastric and superior extremity of the sterno-mastoid muscle,* then passes horizontally backward along the base of the occiput, and divides

* Sometimes external to this muscle.

into two principal branches, which break up into innumerable twigs upon the back part of the head, which anastomose with the posterior auricular and temporal.

Its *Branches* are: 1, a very small one to the sterno-mastoid muscle; 2, a *meningeal* branch, that enters the cranium through the jugular foramen; 3, the *descending cervical* (princeps cervicis), quite large, and the most interesting of the three, which descends beneath the muscles of the back of the neck, and inosculates with the deep cervical branches of the subclavian.

The **Posterior Auricular Artery** (Fig. 198, $_{12}$) is generally small, and comes off a little above the preceding, and sometimes in common with it. It ascends beneath the parotid gland between the external ear and mastoid process, and divides into numerous small twigs that are distributed to the side of the head, and to the internal and external ear.

Branches.—The most important of its branches is one that enters the stylo-mastoid foramen of the temporal bone, traverses the whole length of the Fallopian aqueduct, and is distributed to the tympanum of the ear.

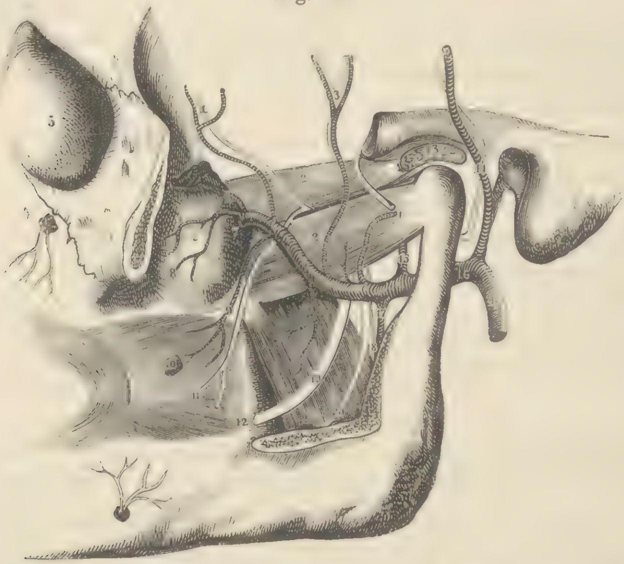
The Internal Branches are the ascending pharyngeal, and the two terminal branches of the carotid, the internal maxillary and temporal.

The **Inferior or Ascending Pharyngeal Artery** (Fig. 198, $_{6}$), the smallest of the named branches of the external carotid, arises from the inner aspect of this vessel nearly opposite the lingual, ascends almost vertically between the internal and external carotid, and at the base of the skull divides into a meningeal and a pharyngeal branch. The former enters the cranium through the jugular foramen, to be distributed to the dura mater; the latter passes inward, and is spent upon the pharynx and soft palate.

The **Internal Maxillary Artery** (Figs. 198 and 199), one of the two terminal divisions of the external carotid, supplies the deep parts about the base of the skull, and is the most difficult artery in the body to trace and understand. In order to be properly exposed, it requires the removal of the zygoma and the anterior half of the ramus of the lower jaw bone, as represented in the annexed plate, when, by carefully following the vessel from its origin, a tolerably good idea may be obtained of its course and the numerous branches which it gives off. Commencing deep in the substance of the parotid gland, it curves around to the inner side of the condyle of the lower jaw, passing between it and the internal lateral ligament of the temporo-maxillary articulation; it then ascends a little, passes between the two pterygoid muscles, and lastly turns abruptly into the pterygo-maxillary fossa, where it gives off its terminal branches. In its course, it first lies between the neck of the condyle and the styloid pro-

cess, the temporo-maxillary ligament intervening; farther on, it is external to the dental and gustatory nerves, and then, having made a curve, the convexity of which projects somewhat between the two heads of the external pterygoid muscle, it enters the pterygo-maxillary fossa.

Fig. 199.



Pterygoid muscles and internal maxillary artery. 1, anterior temporal nerve and artery; 2, external pterygoid muscle; 3, posterior temporal nerve and artery; 4, masseteric nerve and artery; 5, orbital cavity; 6, infraorbital artery; 7, spheno-maxillary fossa; 8, superior dental artery; 9, buccal artery; 10, parotid duct, perforating buccinator muscle; 11, buccal nerve; 12, pterygo-maxillary ligament; 13, interarticular fibro-cartilage; 14, temporal artery and nerve; 15, middle meningeal artery; 16, internal maxillary artery; 17, inferior dental artery; 18, inferior dental nerve; 19, gustatory nerve; 20, mylo-hyoid nerve; 21, internal pterygoid muscle.

Branches.—Its principal branches are fourteen in number, and may be divided arbitrarily into three sets or classes:

1. *Branches given off near the condyle of the lower jaw.*—Tympanic, middle meningeal, inferior dental, posterior deep temporal, masseteric, pterygoid, small meningeal.

2. *Branches given off near the maxillary tuberosity.*—Buccal, anterior deep temporal, alveolar, infraorbital.

3. *Branches given off within the spheno-maxillary fossa.*—Vidian, pterygo-palatine, superior palatine, spheno-palatine.

The *tympanic* is very small, is distributed to the external ear and temporo-maxillary articulation, and penetrates the cavity of the tympanum through the glenoid fissure.

The *middle meningeal*, one of the largest of the branches, passes vertically upward upon the inner side of the condyle of the lower jaw, traverses the spinous foramen of the sphenoid bone, and spreads out in

an arborescent manner upon the surface of the dura mater, being here received into grooves upon the inner side of the parietal and temporal bones. One of its branches within the cranium, sometimes called the *Vidian*, enters the Fallopian aqueduct, and accompanies the facial nerve.

The *inferior dental* arises just beneath the preceding, descends, enters the dental canal, and, having furnished twigs to the several teeth along its course, emerges at the mental foramen. One of its numerous branches, called the mylo-hyoid, leaves the main trunk just before it enters the dental canal, and, descending along the inner surface of the lower jaw, is distributed to the mylo-hyoid muscle.

The *posterior deep temporal*, the next in order, ascends between the external pterygoid and temporal muscles, and then between the latter and the surface of the temporal bone, sending branches to all the adjacent structures.

The *masseteric* is a small twig that passes outward through the sigmoid notch of the lower jaw, to be distributed to the masseter muscle.

The *pterygoid*, three or four in number, and very small, are spent upon the muscles of the same name.

The *small meningeal* arises nearly opposite the inferior dental, passes between the pterygoid muscles and divides into two branches, one of which is distributed to the soft palate and nasal fossæ, and the other, ascending above the external pterygoid, and, entering the cranium through the oval opening of the sphenoid bone, supplies the fifth nerve and the adjacent dura mater.

The *buccal*, very small, often comes off in common with the inferior dental, runs a serpentine course between the ramus of the jaw and internal pterygoid muscle, and is distributed to the buccinator.

The *anterior deep temporal* ascends beneath the anterior border of the temporal muscle, to which, and the subjacent periosteum, it furnishes branches anastomosing with the middle and posterior temporal arteries.

The *superior dental* descends forward upon the maxillary tuberosity, and divides into several branches, which supply the gums and teeth of the upper jaw ; some of them penetrate the antrum and are distributed to its lining membrane.

The *infraorbital* frequently arises in common with the preceding. Commencing opposite the entrance to the spheno-maxillary fossa, it almost immediately enters the infraorbital canal, emerges at the infraorbital foramen, and is distributed to the soft parts of the cheek, anastomosing with the facial and transverse. While in the canal it sends a small twig over the inferior margin of the orbit to the lower eyelid, and another through the anterior dental canal of the canine and incisor teeth.

The *Vidian* or *pterygoid*, very small, traverses the Vidian canal, and is spent upon the pharynx and Eustachian tube.

The *pterygo-palatine*, situated below and internal to the preceding, also very small, passes through the canal of the same name, and is likewise distributed to the pharynx and Eustachian tube.

The *superior palatine* arises opposite the pterygo-maxillary fissure, descends through the posterior palatine canal, and is distributed to the mucous membrane of the mouth, covering the bony palate. It gives off numerous twigs to the soft palate and gums ; and one, the *nasal branch*, which ascends through the anterior palatine canal to the nasal fossæ.

The *spheno-palatine*, the terminal twig of the internal maxillary, traverses the foramen of the same name, near the superior meatus of the nose, and is distributed to the nasal mucous membrane; one of its branches ramifies upon the nasal septum, and anastomoses with the nasal branch of the superior palatine.

The **Temporal Artery**, the other of the two terminal divisions of the external carotid, has been already described. (See page 435.)

The **Internal Carotid Artery** (Fig. 198, $_2$) commences at the bifurcation of the common carotid, opposite the superior border of the thyroid cartilage, ascends almost vertically, in company with the internal jugular vein, to the base of the skull, where it enters the carotid canal in the petrous bone; having traversed this canal, it enters the cranium upon the side of the body of the sphenoid bone, perforates the cavernous sinus lying along the border of the pituitary fossa, and, turning upward beneath and upon the inner side of the anterior clinoid process, enters the fissure between the anterior and middle lobes of the brain, where it divides into the anterior and middle cerebral arteries. The cervical portion of the artery, although generally straight, is sometimes tortuous, especially near its entrance into the carotid canal, where the author has seen it folded back upon itself for the distance of three-fourths of an inch.

At its commencement, the internal carotid is placed upon the outer side of the external carotid, and being here contained in the triangle formed by the sterno-mastoid, omo-hyoid, and digastric muscles, and covered only by the platysma and skin, is easily found by the surgeon when the operation for tying it becomes necessary. A short distance above its origin it is crossed by the hypoglossal nerve and occipital artery, and obliquely by the external carotid; it then becomes placed beneath the digastric and stylo-hyoid muscles and parotid gland, the stylo-pharyngeal and stylo-glossal muscles intervening between it and the external carotid, internal to the jugular vein and anterior to the pneumogastric and sympathetic nerves.

Branches.—It gives off no important branch until it enters the carotid canal in the petrous bone, within which it sends off a small branch to the tympanum of the ear. Having reached the cavity of the cranium and

perforated the cavernous sinus, and before dividing into the two cerebral arteries heretofore mentioned, it sends off the *ophthalmic artery*, which accompanies the optic nerve through the optic foramen into the orbit, and sends its terminal branch through the supraorbital notch to the skin of the forehead, as heretofore described.

The nearness of the internal carotid to the pharynx explains how it may be wounded in operations upon the lateral wall of this cavity, and more especially how it is occasionally cut in excision of the tonsils.

The cranial portion of the internal carotid has been already referred to as part of the arterial system of the brain (p. 402).

The Subclavian Artery (Figs. 198, $_{16}$, and 200). The *right* subclavian originates from the brachio-cephalic or innominate artery behind the corresponding sterno-clavicular articulation, and the *left* from the arch of the aorta; both traverse the lower part of the neck in the same manner on their way to the arm, forming a curve with its convexity presented upward. In their course both are crossed, in the neck, by the anterior scalene muscle, and are, therefore, considered as divided into three parts, the first extending from the origin of the vessel to the inner edge of this muscle, the second situated behind the muscle, and the third reaching from the outer border of the muscle to the first rib, over which the artery passes to enter the axilla.

The *first division of the right subclavian* is about an inch in length, and, although deeply seated, is less so than the left; it passes almost directly outward, arching very slightly above the level of the clavicle, and has, lying in front of it, the extremities of the subclavian and internal jugular veins, the sterno-mastoid, sterno-hyoid, and sterno-thryoid muscles; it is crossed by the vertebral vein, pneumogastric nerve, and branches of the sympathetic; separated behind from the transverse process of the seventh cervical vertebra by the long muscle of the neck (longus colli), the recurrent laryngeal nerve, and a variable quantity of areolar and adipose tissue; and in contact below with the pleura, by which it is separated from the apex of the lung.

The *first division of the left subclavian* is as much longer than the right as the length of the innominate artery, say about an inch and a quarter; it ascends almost vertically from its origin within the chest, between the trachea and upper lobe of the left lung, to the lower part of the neck, where its relations are very similar to those of the right, except that it is more deeply seated, is covered to a greater extent by the pleura, and has the recurrent laryngeal nerve and thoracic duct lying to its inner side.

The second and third divisions of the two arteries are the same.

The *second or middle division of the subclavian* is the highest part of the artery, and is situated between the anterior and posterior scalene

muscles, from the latter of which it is separated by the brachial plexus of nerves, and by the former from the subclavian vein and phrenic nerve.

Fig. 200.

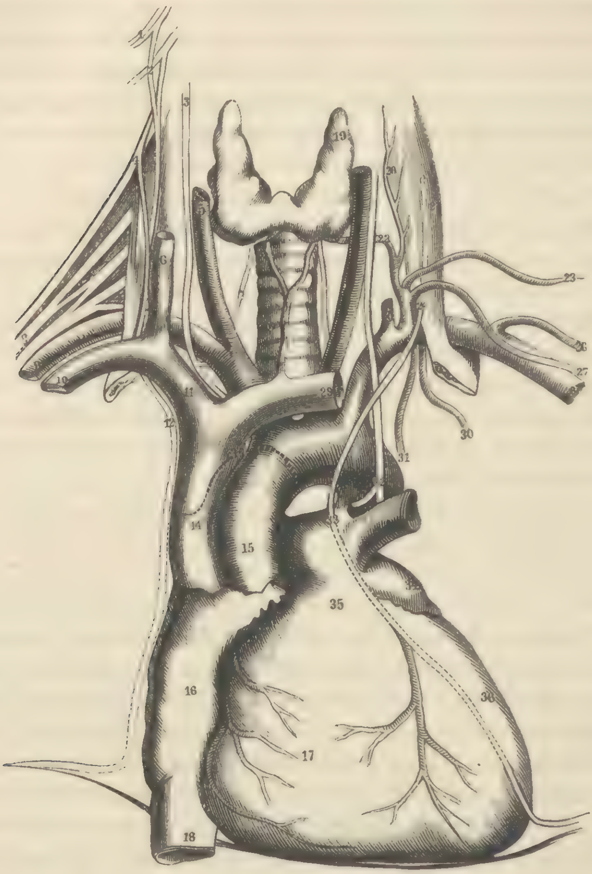


Diagram of heart and adjacent vessels and nerves; branches of right subclavian artery, corresponding to those of left, are not exhibited in this diagram. 1, third cervical nerve; 2, fourth cervical nerve; 3, pneumogastric nerve; 4, fifth cervical nerve; 5, right carotid artery; 6, right jugular vein; 7, recurrent laryngeal nerve; 8, brachial plexus of nerves; 9, right subclavian artery; 10, right subclavian vein; 11, right innominate vein; 12, 24, 33, phrenic nerve; 13, line of attachment of pericardium; 14, superior cava; 15, aorta; 16, right auricle; 17, right ventricle; 18, inferior cava; 19, thyroid body; 20, ascending cervical artery; 21, anterior scalene muscle; 22, inferior thyroid artery; 23, superficial cervical artery; 25, vertebral artery; 26, posterior scapular artery; 27, suprascapular artery; 28, left subclavian artery; 29, left innominate vein; 30, superior intercostal artery; 31, internal mammary artery; 32, pneumogastric nerve; 34, appendix of left auricle; 35, root of pulmonary artery; 36, left ventricle.

The *third division of the subclavian* curves outward and downward from the external border of the scalene muscles beneath the clavicle and over the first rib, traversing the omo-clavicular triangle. As this is the

portion usually selected by surgeons for the application of the ligature, the student should examine it carefully, both with reference to its relations and its depth from the surface. It is covered by the skin, platysma, and a quantity of areolar and adipose tissues, through which, and along the posterior border of the clavicle, runs the posterior scapular artery, although this is by no means constantly the case. The subclavian vein is situated in front of and somewhat below the artery, and the brachial plexus of nerves immediately upon its superior and external border. The depth of this division of the artery from the surface varies in different individuals from half an inch to an inch and a half, or even more, depending partly upon the prominence of the clavicle, and partly upon the development of adipose tissue; and the frequent difficulty of reaching it, without making a dangerously large incision, must have struck every one who has performed dissections of this region.

No artery in the body presents more numerous variations in reference to the number and arrangement of its branches; and the order here laid down, although, according to the author's observation the most common, may not be found to apply strictly to more than one subject out of three. The more common varieties will be referred to in the description of the individual branches and their subdivisions.

Branches of the Subclavian.—The branches of the subclavian are, the vertebral, thyroid axis, internal mammary, superior intercostal, and deep cervical.

The **Vertebral Artery** (Fig. 198, $_{18}$), the first and largest of the branches of the subclavian, arises from the upper back part of the first division of this vessel, where it lies in front of the transverse process of the seventh cervical vertebra. It ascends, inclining a little backward, enters the foramen in the transverse process of the sixth cervical vertebra, traverses the corresponding foramina of the several vertebræ above, and from the transverse process of the atlas makes a horizontal curve around the base of the superior articular process of this bone, to reach the spinal foramen of the occipital bone. Having entered the cranium, each artery passes forward and inward beneath the medulla oblongata, and upon the basilar process of the occipital bone they unite to form the basilar artery, as heretofore described. Before entering the transverse foramen of the sixth cervical vertebra, it lies close upon the anterior surface of the transverse process of the seventh, immediately to the inner side of the scalene muscle, and behind the inferior thyroid artery. The artery of the left side has also a close relation in front with the thoracic duct, which here curves forward from behind the subclavian artery to terminate in the back part of the subclavian vein, just where the latter unites with the internal jugular to form the left innominate vein.

The left vertebral occasionally originates from the arch of the aorta,

and not unfrequently either the one or the other enters the foramen in the transverse process of the fifth or fourth cervical vertebra, instead of the sixth.

Branches.—The vertebral sends off a few small twigs to the structures with which it is in relation in the lower part of the neck, and from its horizontal curve upon the atlas a more considerable branch, called the *posterior meningeal*, to the dura mater. Its branches within the cranium have been already enumerated.

The **Thyroid Axis** is a very short, but large trunk, arising from the anterior aspect of the first division of the subclavian, very near the inner border of the anterior scalene muscle, having the phrenic or diaphragmatic nerve lying along its outer side. At a short distance, generally not more than a fourth or an eighth of an inch from its origin, it divides into four branches, the inferior thyroid, ascending cervical, posterior scapular, and suprascapular.

The **Inferior Thyroid Artery** (Figs. 198 and 200), the second in point of size, passes in a tortuous manner obliquely upward and inward behind the common carotid, internal jugular vein, and pneumogastric and recurrent laryngeal nerves, to the inferior extremity of the corresponding lobe of the thyroid gland, to which organ it is distributed, and in the substance of which it anastomoses with the superior thyroid, a branch of the external carotid (Fig. 201). It not unfrequently originates directly from the subclavian, and generally sends a small branch to the back part of the larynx, and a few twigs to the trachea.

The **Ascending Cervical Artery**, the smallest of the four divisions of the thyroid axis, originates about as often from the inferior thyroid. It ascends almost vertically, lying close upon the anterior surfaces of the transverse processes of the vertebræ, and is distributed to the adjacent muscles.

The **Posterior Scapular or Transverse Cervical Artery** (Figs. 198 and 200), the largest of the group, originates almost as frequently from the third division of the subclavian as from the first. From the thyroid axis it curves transversely across the front of the anterior scalene muscle and diaphragmatic nerve, traverses the omo-clavicular triangle, in which are contained the third portion of the subclavian artery and brachial plexus of nerves, sometimes resting immediately upon, and sometimes above them, and frequently running close along the posterior border of the clavicle. It then passes behind the clavicular attachment of the trapezius muscle, turns downward along the posterior border of the scapula, and supplies all the adjacent muscles, anastomosing with the subscapular, which is a branch of the axillary artery (Fig. 201). Where it crosses the triangular space above mentioned it is, of course, in the way of an operation upon the third portion of the subclavian; and the frequency of this

occurrence should be taken into consideration. In the neck it gives off numerous small branches, the most important of which is the *superficial cervical*, which ascends behind the posterior border of the trapezius to the muscles upon the back of the neck.

When the posterior scapular originates from the third portion of the subclavian it curves immediately backward in front of or through the brachial plexus of nerves; and, in this case, the superficial cervical is a branch either of the thyroid axis or first portion of the subclavian. It sometimes arises also in common with the suprascapular.

The **Suprascapular Artery** (Figs. 198 and 200), smaller than the preceding, is almost constantly a branch of the thyroid axis, although occasionally of the preceding. From its origin it descends outward to gain the posterior border of the clavicle, along which it passes to the superior edge of the scapula, crosses above the ligament of the suprascapular notch, and is distributed to the muscles upon the back of the scapula. This vessel is probably oftener in the way of an operation upon the third division of the subclavian than the preceding. It inosculates with the dorsal branch of the subscapular (Fig. 201).

The **Internal Mammary Artery** (Fig. 198), nearly as large as the vertebral, arises from the lower back part of the first division of the subclavian opposite the thyroid axis, descends immediately into the cavity of the thorax across the posterior surface of the cartilage of the first rib, and thence along the border of the sternum, to be distributed to the muscles of the anterior part of the thorax and abdomen, as will be hereafter seen. It is covered internally by the

Fig. 201.

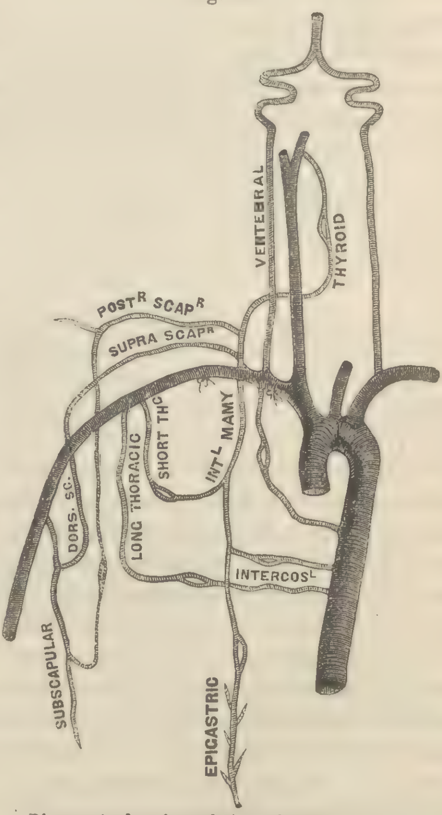


Diagram to show inosculations of subclavian artery.

pleura, crossed obliquely below its origin by the diaphragmatic or phrenic nerve, and separated from the inner end of the clavicle, behind which it is situated, by the corresponding innominate or brachio-cephalic vein. It inosculates freely with the epigastric, a branch of the external iliac (Fig. 201).

The **Superior Intercostal Artery** (Fig. 200), occasionally absent, and not unfrequently a branch of the thyroid axis, or even of the vertebral or internal mammary, arises commonly from the inferior posterior aspect of the subclavian, close beneath the inner border of the anterior scalene muscle, descends beneath the pleura in front of the necks of the first and second ribs, and terminates by dividing into the first two intercostal arteries. It anastomoses with the third intercostal, a branch of the aorta (Fig. 201).

The **Deep Cervical Artery**, often a branch of the preceding, ascends backward and outward between the transverse process of the last cervical vertebra and first rib, and divides into an ascending and descending branch, which supply the neighboring muscles of the back. The ascending branch anastomoses with the descending branch of the occipital.

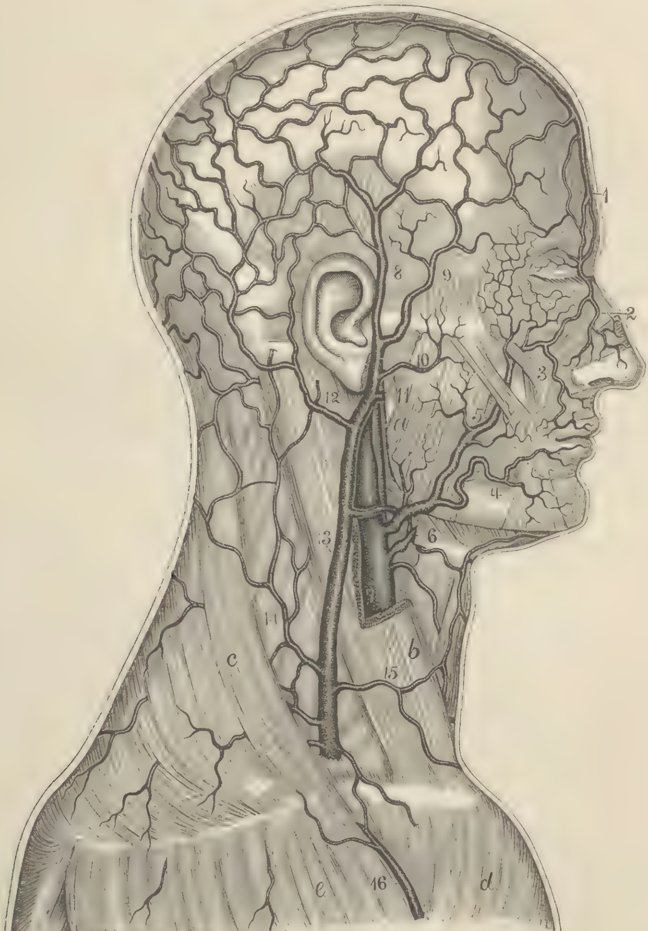
The Veins of the Neck, for the most part, correspond to the arteries, there being generally one accompanying vein to each artery; and all assist in forming the two main trunks, the internal jugular and subclavian.

The **Internal Jugular Vein** (Fig. 202) is the principal vein of the head and neck, and is the accompanying vein of the common and internal carotid arteries. It commences at the base of the skull in the jugular foramen, being here continuous with the lateral sinus of the dura mater; descends along the outer side of the internal carotid artery as far as the hyoid bone, where it becomes inclosed in the same sheath with the pneumogastric nerve and common carotid artery, lying to the outer side of the latter; and at the root of the neck it joins the subclavian vein to form the brachio-cephalic or innominate vein. Its size varies in different individuals, and often upon the two sides of the same person; but in general it is not less than three times as large as the artery which it accompanies, and, when distended with blood or other fluid, overlaps the latter to a greater or less extent; a fact that should be borne in mind in operating upon either the internal or primitive carotid.

In the upper part of its course it receives a number of small veins, as, for instance, the lingual, pharyngeal, a communicating branch from the external jugular (see p. 449), occipital, etc., and opposite the hyoid bone it is joined by the facial and temporal, in conjunction or separately. Here

the vessel undergoes a considerable enlargement, corresponding to the large size of the primitive carotid, along which it lies in the rest of its course. About the middle of the neck it receives the middle and superior thyroid veins, and, lower down, the inferior thyroid and anterior jugular veins.

Fig. 202.



Veins of head and neck. 1, frontal vein; 2, nasal vein; 3, 4, labial veins; 5, facial vein; 6, lingual vein; 7, internal jugular vein; 8, 9, posterior and anterior temporal veins; 10, transverse facial vein; 11, internal maxillary vein; 12, posterior auricular vein: 13, external jugular vein; 14, posterior, 15, anterior jugular veins. *a*, external carotid artery; *b*, sterno-mastoid muscle; *c*, trapezius; *d*, pectoral muscle; *e*, deltoid muscle.

The **Anterior Jugular Vein** (Fig. 202), often absent, and at best of small size, is situated beneath the skin, a little way removed from the median line. It collects the blood from the anterior parts of the neck,

descends at first vertically and then outward, and opens into the subclavian or internal jugular near their junction.

The **Subclavian Vein** (Fig. 200) is situated at the root of the neck, behind and beneath the clavicle, and is generally somewhat larger than the internal jugular. From the axilla, where it is called the axillary vein, it crosses the first rib just in front of the insertion of the anterior scalene muscle, and is therefore anterior to and some little distance below the third division of the subclavian artery. It passes directly in front of the first division of the artery, and joins the internal jugular at a right angle, to form the brachio-cephalic or innominate vein. Outside of the scalene muscle it receives the external jugular, and sometimes the posterior and superior scapular veins; and at its junction with the internal jugular, on the right side, it is joined by the main trunk of the lymphatics of the corresponding side of the head and neck, and, on the left, by the thoracic duct from behind.

The **Vertebral Vein**, also partly seen in this dissection, accompanies the artery of the same name, and, leaving the foramen in the transverse process of the sixth cervical vertebra, descends forward in front of the first division of the subclavian artery, to open into the corresponding division of the subclavian vein.

Thyroid Veins.—The *Superior Thyroid Veins* accompany the corresponding arteries and terminate in the internal jugular. The *Inferior and Middle* vary in number from one to three or four, and are, in a surgical poiut of view, among the most important vessels of the neck. They originate in the substance of the thyroid body, from the lower extremities of the lobes of which they descend and form a plexus of considerable size, immediately in front of the trachea, and lie therefore directly in the course of the operation of tracheotomy. They terminate generally in the right and left innominate veins.

The principal Nerves of the Neck are the glosso-pharyngeal, pneumogastric, spinal accessory, hypoglossal, gustatory, cervical plexus, brachial plexus, and sympathetic, and their numerous branches of distribution.

The **Glosso-pharyngeal Nerve** (Fig. 203, $_{16}$) is situated deep in the upper part of the neck. It is seen after the removal of the stylo-hyoid muscle and posterior belly of the digastric, descending forward from the jugular foramen between the internal jugular vein and internal carotid artery, beneath the styloid process, and then along the inner border of the stylo-glossal muscle, forming a curve with its concavity presenting upward. It sends branches in the neck to the stylo-pharyngeal, stylo-

hyoid, digastric, and proper pharyngeal muscles, the tonsils, mucous lining of the pharynx, and muscular and mucous structure of the back part of the tongue.

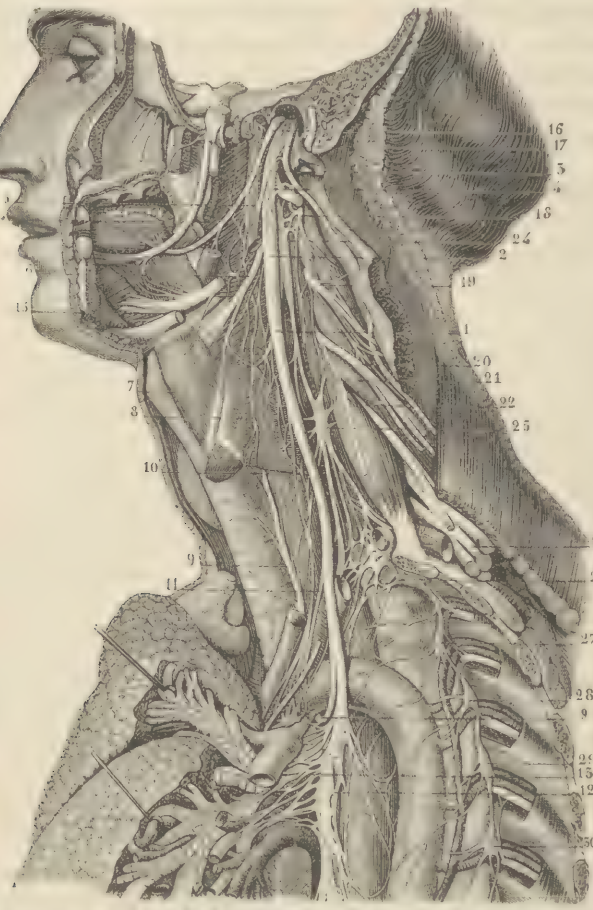
Branches.—The glosso-pharyngeal originates from the upper part of the groove between the olivary and restiform bodies of the medulla oblongata, leaves the cranium at the jugular foramen, lying here internal to the jugular vein, and in front of the pneumogastric and spinal accessory nerves; it descends between the vein and internal carotid artery, curves forward in front of the artery beneath the styloid process and its three muscles, winds around the stylo-pharyngeal muscle, and thence along the inner aspect of the stylo-glossal to the tongue. Within the jugular canal it presents two enlargements or ganglia: the superior very small, and involving only a portion of the thickness of the nerve, called the *jugular ganglion;* and the inferior, much larger, which comprises all the fibres of the nerve, lodged in a small depression of the petrous bone, and hence called the *petrous ganglion* or the ganglion of Andersch. Communicating branches extend between this ganglion and the pneumogastric, facial and sympathetic nerves, and from it are given off numerous filaments to surrounding parts. The most interesting of these branches is the *tympanic branch* or Jacobson's nerve, which reaches the tympanum through a minute opening situated upon the anterior wall of the jugular notch, and, having given off a small filament to form a plexus (tympanic plexus) with a twig from the sympathetic, is distributed to the lining membrane of the tympanum and Eustachian tube, sending branches also to the fenestra, carotid plexus, large superficial petrosal nerve, and otic ganglion.

The **Pneumogastric Nerve** (nervus vagus, par vagum) makes its appearance in the neck at the jugular foramen, upon the inner side of the internal jugular vein, descends, inclosed in the same sheath with this vessel and the internal and primitive carotid arteries. At the root of the neck in front of the first portion of the right subclavian artery, but parallel to the left, it inclines a little inward to reach the œsophagus, by the side of which it is continued into the thorax and abdomen.

Branches.—The pneumogastric nerve originates from the groove upon the medulla oblongata, immediately below the spinal accessory, by a large number of filaments, which are collected into a flat bundle before leaving the cranium. In the jugular foramen the nerve is anterior to the vein, and presents a small enlargement, involving only a part of its thickness, called the ganglion of the root of the pneumogastric. From this ganglion one or two filaments are given off to the spinal accessory; another, called the *auricular branch*, receives a filament from the glosso-pharyngeal, enters a foramen in the petrous bone near the styloid process, traverses the bone across the Fallopian aqueduct, and, emerging between the mastoid process and external auditory meatus, is distributed to the integument and cartilage of the ear.

Immediately after leaving the jugular foramen, the pneumogastric receives the internal or accessory branch of the spinal accessory, and then enlarges into a reddish-gray ganglion of a cylindrical form, and nearly an

Fig. 203.



Pneumogastric nerve. 1, trunk of pneumogastric; 2, gangliform plexus; 3, anastomosis of latter with accessory nerve; 4, anastomosis with hypoglossal; 5, pharyngeal nerve; 6, superior laryngeal nerve; 7, its external branch; 8, pharyngeal plexus; 9, inferior laryngeal nerve; 10, 11, filaments to cardiac plexus; 12, commencement of œsophageal plexus; 13, pulmonary plexus; 14, lingual nerve; 15, lower part of hypoglossal nerve; 16, glosso-pharyngeal nerve; 17, accessory nerve; 18, 19, 20, second, third, and fourth cervical nerves; 21, commencement of phrenic nerve; 22, 23, lower four cervical nerves forming with the first thoracic nerve brachial plexus; 24, 25, first and second cervical ganglia of sympathetic; 26, third cervical united with first thoracic ganglion; 27–30, second to fifth thoracic ganglia.

inch (ten lines) in length, which comprises the whole thickness of the cord, excepting the spinal accessory branch, and is sometimes called the *gangliform plexus* (Fig. 203, $_2$).

This ganglion receives communicating filaments from the glosso-pharyngeal, first cervical ganglion of the sympathetic, and cervical plexus; and gives off two important branches—the pharyngeal and superior laryngeal.

The **Pharyngeal Nerve**[5] descends behind the internal carotid artery to the back of the pharynx, and is distributed to the constrictor muscles and lining membrane of this cavity, forming here, with branches from the glosso-pharyngeal, superior laryngeal, and sympathetic nerves, the *pharyngeal plexus.*

The **Superior Laryngeal Nerve**,[6] quite large, and at first deeply seated, descends forward, passing behind the internal carotid artery, and, having sent communicating filaments to the superior ganglion of the sympathetic, lingual nerve, and pharyngeal plexus, divides into an external and an internal branch. The *external* division is distributed to the sterno-thyroid, sterno-hyoid, and crico-thyroid muscles, and thyroid body; the *internal* perforates the membrane between the hyoid bone and thyroid cartilage (thyro-hyoid membrane), in company with the laryngeal artery, and is distributed to the mucous membrane lining the larynx.

From the origin of the superior laryngeal to the base of the neck, the pneumogastric furnishes only a few minute filaments, called *cervical cardiac branches,* which join the cardiac offsets of the sympathetic. The largest one of these comes off in the lowest part of the neck, and descends into the thorax, upon the right side, along the brachio-cephalic or innominate artery, and on the left over the arch of the aorta.

The **Inferior** or **Recurrent Laryngeal Nerve** (Figs. 200 and 203) arises from the pneumogastric, upon the right side, opposite the lower border of the first portion of the subclavian artery, behind which it ascends, and on the left opposite the arch of the aorta, around which it winds, and returns to the neck. Upon either side it is situated in the groove between the œsophagus and trachea, sends off a few filaments to the anterior part of the trachea, thyroid body, and lower part of the pharynx, and is finally distributed to the interior muscles of the larynx.

Entering the thorax, the Pneumogastric Nerves accompany the œsophagus down the posterior mediastinum, and give off cardiac and pulmonary branches.

The *Cardiac Branches* join the cardiac branches of the cervical ganglia of the sympathetic, and assist in forming the cardiac plexus from which the heart is principally supplied.

The *Pulmonary Branches* are numerous and large, and form, with filaments from the upper thoracic ganglia of the sympathetic, a large plexus upon the posterior surface of the root of the lung. This is termed the

posterior pulmonary plexus, the branches of which enter the lung upon the bronchial tubes, and are distributed throughout the organ.

Below the root of the lung the pneumogastric nerves form an intricate plexus around the œsophagus, and continue in this relation into the abdomen, where the right nerve is distributed to the posterior wall of the stomach, and sends branches to the solar plexus of the sympathetic; and the left is distributed to the anterior wall and pyloric extremity of the stomach, and furnishes one or more offsets to the hepatic plexus of the sympathetic.

The **Spinal Accessory Nerve** is found in the upper part of the neck beneath the sterno-mastoid muscle, and, upon turning the muscle outward, the nerve is seen perforating its posterior border from above, downward and outward. It arises by several roots, as heretofore described, from the side of the spinal cord, between the anterior and posterior roots of the spinal nerves, as low as the fourth cervical vertebra; ascends and enters the cranium through the occipito-spinal foramen, and again leaves this cavity at the jugular foramen, in the same sheath with the pneumogastric. Within the jugular foramen it communicates with the superior ganglion of the pneumogastric, and immediately beyond its exit divides into two branches; an *internal* or *accessory*, which joins the pneumogastric above, but does not enter into the formation of the lower ganglion of this nerve; and an *external*, larger, which descends outward and backward, sometimes in front of and sometimes behind the internal jugular vein, perforates the sterno-mastoid muscle, supplying it with branches, and dips beneath the anterior border of the trapezius muscle, to which its terminal divisions are distributed.

The **Hypoglossal Nerve** (*lingual nerve*, Fig. 203, $_{15}$) is seen in the upper part of the neck, curving transversely across the internal and external carotid arteries, following the lower border of the posterior belly of the digastric muscle, and then turning upward to reach the side of the tongue, beneath the posterior margin of the mylo-hyoid muscle. It originates from the outer side of the anterior pyramidal body of the medulla oblongata, leaves the cranium through the anterior condyloid foramen, passes downward and forward between the internal jugular vein and internal carotid artery, runs along the lower border of the digastric muscle, then curves upward across the occipital and external carotid arteries, enters between the mylo-hyoid and lower portion of the hyo-glossal muscles, and is continued in the substance of the genio-hyo-glossal to the tip of the tongue, being distributed solely to the muscular tissue of this organ. Soon after leaving the cranium, it has communicating filaments with the pneumogastric and first ganglion of the sympathetic nerve, and gives off near the occipital artery a long descending branch,

called technically the *descendens noni*, which descends upon the sheath of the jugular vein and carotid artery, forming about the middle of the neck a loop with a branch from the pneumogastric and cervical nerves. From this loop, the convexity of which is directed downward, filaments are given off to the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles.

The ultimate branches of the hypoglossal nerve supply the stylo-glossal, thyro-hyoid, hyo-glossal, and genio-hyo-glossal muscles.

The **Gustatory** or **Lingual** branch of the inferior maxillary division of the Trifacial Nerve* (Fig. 203, $_{14}$) makes its appearance deep in the upper part of the neck, upon the inner side of the base of the lower jaw near its angle, whence it turns forward across the upper part of the hyo-glossal muscle above the submaxillary gland, and, continuing beneath the mucous membrane of the mouth and above the mylo-hyoid muscle, is distributed to the papillæ of the tongue as far as its tip. In its course, it sends branches to the palate, pharynx, gums, submaxillary and sub-lingual glands.

The Sympathetic Nerve.—The cervical division of the sympathetic, seen in this dissection, descends from the base of the cranium close along the sides of the bodies of the vertebræ, behind the common sheath of the jugular vein, carotid artery, and pneumogastric nerve, and enters the thorax over the first portion of the subclavian artery. In its course, it presents three ganglionic enlargements with numerous branches of com-munication and distribution. The *superior* (Fig. 203, $_{24}$), the largest of these ganglia, is situated upon the second and third cervical vertebræ; it is about an inch in length, fusiform in shape, of a reddish-gray color, and smooth surface. The *middle*,[25] very small and frequently wanting, is situated opposite the fifth or sixth vertebra in front of the inferior thyroid artery, and varies in shape in different individuals. The *inferior*,[26] larger than the preceding and of a crescentic shape, may be found either upon the transverse process of the seventh cervical vertebra, or between this and the first dorsal vertebra, near the head of the first rib and behind the vertebral artery.

Branches.—The *Superior Cervical Ganglion* gives off superior, in-ferior, internal, external, and anterior branches. The *superior*, two in number, enter the cranium through the carotid canal of the petrous bone. They form upon the internal carotid artery and cavernous sinus the carotid and cavernous plexuses, from which branches are sent to the tympanum, and communicating filaments to the spheno-palatine, sixth, and Jacobson's nerves, Gasserian ganglion, orbital plexus, and lenticular ganglion. The

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* For a connected account of the branches of the trifacial nerve and their dis-tribution, see chapter at the close of the book.

inferior is the central cord that descends to the middle ganglion. The *anterior* are very numerous, and accompany the branches of the external carotid artery, and also form communications with the spinal accessory, glosso-pharyngeal, pneumogastric, and hypoglossal nerves. The *external* pass directly outward, and join the first three or four cervical nerves as they emerge from the spinal canal. The *internal* are very numerous; some of them accompany branches of the external carotid artery to the tongue, thyroid body, face, etc.; some go to the pharynx and larynx, and one to the heart. This last mentioned, called the *upper cardiac nerve*, arises from the lower extremity of the ganglion, descends behind the sheath of the jugular vein and carotid artery, but in front of the inferior thyroid artery, and enters the chest sometimes in front of and sometimes behind the first portion of the subclavian artery, to join the great cardiac plexus upon the concavity of the arch of the aorta.

The *Middle Ganglion* communicates above and below with the other two; externally, with the third, fourth, and fifth cervical nerves; and from its inner side sends off the *middle cardiac nerve*, which descends behind the sheath of the common carotid artery either in front of or beneath the first portion of the subclavian artery, and joins the deep cardiac plexus above mentioned.

The *Inferior Ganglion* sends a common trunk to the middle, and communicating filaments to the diaphragmatic, brachial, and recurrent laryngeal nerves; and from its internal aspect originates the *inferior cardiac nerve*, which descends to the cardiac plexus, communicating in its course with the pneumogastric and recurrent laryngeal nerves.

The **Cervical Nerves** from the spinal cord, eight in number on each side, emerge from the spinal canal through the corresponding intervertebral foramina, and divide into anterior and posterior branches. The anterior branches of the first four unite to form the cervical plexus, and those of the inferior four, the brachial plexus. The posterior branches are distributed to the muscles of the back.

The **Cervical Plexus** is situated upon the side of the upper part of the neck, beneath the posterior border of the sterno-mastoid muscle, and in front of the lateral attachments of the muscles of the back of the neck. It is formed by the union of the anterior divisions of the upper four cervical nerves, each of which, except the first, divides into a descending and an ascending branch that communicate together above and below.

Branches.—Its branches form a superficial and deep set. The *superficial* set consists of ascending and descending branches, the former comprising the superficial cervical, auricular, and small occipital nerves, and the latter the supraclavicular nerves, all of which have been already mentioned. The *deep* set consists of communicating filaments to the

pneumogastric, hypoglossal, glosso-pharyngeal, and sympathetic nerves, and numerous muscular branches, namely, to the trapezius, elevator of the scapula, sterno-mastoid, sterno-hyoid, omo-hyoid, sterno-thyroid, posterior scalene muscles, and diaphragm. The most interesting of these are the diaphragmatic, and the branch to the subhyoid muscles.

The *Diaphragmatic* or *Phrenic nerve* (Figs. 200 and 203, $_{21}$) is derived from the anterior divisions of the third and fourth, and sometimes also from the fifth cervical nerves. It descends obliquely inward over the anterior scalene muscle, and enters the thorax across the root of the internal mammary artery. Within this cavity, it is bound by the pleura to the side of the pericardium, along which it passes to its ultimate distribution upon the diaphragm. It sends also a small branch to the liver, suprarenal capsule, and inferior cava vein.

The *Subhyoid Branch* of the cervical plexus, called technically the *communicans noni*, arises from the second and third nerves, descends inward beneath the sterno-mastoid muscle, and, about opposite the thyroid body, joins the descending branch of the hypoglossal upon the sheath of the carotid artery and jugular vein in the form of a loop, from which branches are given off to the depressor muscles of the larynx. This nerve is often double.

The **Brachial Plexus** (Figs. 200 and 203, $_{23}$) is situated in the lower external part of the neck, and is formed by the union of the anterior divisions of the lower four cervical nerves and first dorsal, which emerge from the corresponding intervertebral foramina between the anterior and posterior scalene muscles. It is placed above and external to the third division of the subclavian artery, and beneath the posterior belly of the omo-hyoid muscle; it is at first broad and flat, but becomes narrower and more closely related to the artery, as it descends over the first rib beneath the clavicle toward the axilla, where it forms the axillary plexus.

The *Branches* above the clavicle are the posterior thoracic, suprascapular, and small filaments to the adjacent muscles and diaphragmatic nerve.

The *posterior* or *lateral thoracic* arises close to the spine in the substance of the posterior scalene muscle, and descends behind the plexus to the lateral parts of the thorax, and is distributed principally to the great serrate muscle.

The *suprascapular* comes from the upper part of the plexus, descends obliquely beneath the anterior edge of the trapezius muscle, passes through the suprascapular notch, and is distributed to the muscles on the back of the scapula.

The axillary branches will be seen hereafter.

THE THYROID BODY.

Before leaving the neck, the student should examine this singular organ (commonly called a *gland*, although it possesses no excretory duct), situated upon the front and sides of the upper part of the trachea, beneath the sterno-hyoid and sterno-thyroid muscles (Fig. 200). It is of a brownish or dusky-red color, nearly symmetrical, but unlike any familiar object in shape, unless it be a pair of old-fashioned saddle-bags. It consists of two large lateral lobes, and an intervening narrow flattened portion, denominated the isthmus.

The *Lobes* are of a flattened pyriform shape, and about two inches in length, the right somewhat the larger; they rest upon the sides of the trachea, the lower and larger extremity reaching as low as the sixth ring of this tube, the apex touching the side of the thyroid cartilage, and the posterior or outer margin in contact with the sheath of the common carotid artery and jugular vein; the left touching also the side of the œsophagus.

The *Isthmus* is of very variable shape and size, but in general about half an inch broad and quarter of an inch thick. It rests upon the front of the second, third, and fourth rings of the trachea, and is continuous with the lateral lobes near their larger extremities. Frequently, however, it is quite large, constituting a *middle lobe*, which is prolonged upward in the median line, in a pyramidal form, sometimes as far as the lower margin of the thyroid cartilage. A flattened muscle (elevator of the thyroid gland) sometimes extends from the upper border of the isthmus to the hyoid bone, only a single instance of which, however, has come under the author's observation.*

Structure.—The thyroid body is composed in part of a strong, transparent, fibrous capsule, from the inner surface of which proceed numerous processes or septa, which divide the organ imperfectly into small irregular lobules. These lobules are farther divisible into minute closed vesicles of various forms, which have well-marked fibrous walls, and inclose a fluid containing numerous granular nuclei of a rounded or oval form, and a few perfect cells of greater size.

The vessels of the thyroid body are numerous and remarkable for their large size. Its *arteries*, four in number, two superior and two inferior, come from the external carotids and subclavians; to which is occasionally added a fifth, called the *middle thyroid*, that generally arises from the innominate, sometimes from the arch of the aorta, between the innominate and the left carotid; it ascends in front of the trachea, and is never of

* In this case the muscle was nearly or quite as large as the sterno-hyoid, and proceeded directly up the middle of the neck in front of the larynx to the hyoid bone.

any very great size; but, notwithstanding, might give rise to some inconvenience if cut in tracheotomy. The *veins* are very large, and form on each side a superior, middle, and inferior trunk, the first two pairs of which open into the internal jugulars, but the inferior form an intricate anastomosis in front of the trachea, and terminate, the right in the inferior cava vein, and the left in the left brachio-cephalic. The *lymphatics* are very numerous and very large. The *nerves* are few and small, and come from the pneumogastric and sympathetic.

The function of this body has yet to be discovered. Its size in the fœtus is relatively much greater than in after-life, and is somewhat greater in the female than in the male. Its enlargement or hypertrophy, which is sometimes enormous, constitutes the disease called *goitre.*

THE CAVITY OF THE MOUTH.

The Cavity of the Mouth is ovoidal, flattened vertically, and its axis, unlike that of any of the inferior animals, is directed horizontally from before backward. It is bounded above by the hard palate; below, by the tongue and the mylo-hyoid muscles; in front by the gums, dental arches, and lips; laterally, by the gums, teeth, and cheeks; and posteriorly, by the soft palate. It communicates in front with the external air, and behind with the pharynx by a considerable opening, called the *isthmus of the fauces*, which will be more particularly described hereafter.

The **Lips**, the two musculo-membranous doors that guard the external opening to the mouth, and whose form and uses are familiar to every one, consist principally of skin, muscle, and mucous membrane, together with a layer of little glandular organs, and numerous vessels and nerves. The skin is dense and thick, and, in the male adult, covered with hair; it is closely adherent to the subjacent muscular layer, and at the free margins of the lips is continuous with the mucous lining of the mouth. The mucous membrane covers the posterior or internal surfaces of the lips, and forms in the middle line of each a small vertical fold or *bridle* (frænum), by which they are connected to the gums. The *glandular layer* is situated beneath the mucous membrane, and consists of numerous small spherical, racemose glands (labial glands), about the size and shape of a grain of wheat, arranged very closely side by side, and opening by small, separate, excretory ducts upon the free surface of the mucous membrane. The *muscular layer* is subjacent to the skin, and is composed of the orbicular or sphincter muscle, and the adjacent extremities of the numerous muscles that are inserted into its outer margin. The *arteries* are the four coronary branches of the facial. The *veins* follow the course of the arteries. The *nerves* to the skin and mucous membrane are

branches of the fifth or trigeminal, and of the facial, to the muscular tissue.

The **Cheeks** are continuous with the lips, and are composed essentially of the same structures; but the muscular layer is formed by the buccinator, and the glands (buccal glands) are more scattered. The mucous membrane, like that of the lips, is covered by a scaly or tessellate epithelium, and perforated upon each side about its middle, and opposite the second molar tooth of the upper jaw, by the duct of the parotid gland.

The **Hard Palate** or roof of the mouth is formed by the palate processes of the superior maxillary and palate bones; it is covered by mucous membrane, beneath which is a dense fibrous or periosteal membrane, and between the two a number of glands like those found in the lips and cheeks. Its surface is slightly concave, but uneven, traversed in the middle line from before backward by a seam corresponding to the union of the bones, and marked just behind the middle incisor teeth by a little papilla, which corresponds to the inferior termination of the naso-palatine canal, and is said to be endowed with a peculiar sensibility.

The **Gums** are formed by the alveolar arches, covered by dense periosteum and mucous membrane continuous with that of the lips and cheeks, but remarkable for its insensibility. The mucous membrane is closely in contact with the necks of the teeth, but not adherent to them; the fibrous membrane, however, dips into and lines the sockets, and thus attaches the roots of the teeth firmly in their places.

THE TONGUE.

The Tongue, the special organ of the sense of taste, is oval in shape, flattened from above downward, pointed anteriorly and attached posteriorly to the body of the hyoid bone. Its superior surface, lateral margins, and tip are free, and covered by mucous membrane; its inferior surface is continuous with the genio-hyo-glossal, stylo-glossal, and lingual muscles. The mucous membrane of the tongue is continued from the superior surface behind upon the anterior surface of the epiglottis, forming, in the middle line, a triangular fold, called the bridle or *frænum of the epiglottis.* A short distance external to the bridle, and separated from it by a little depression, are two smaller folds, one on each side, attached to the margins of the epiglottis. From the under surface of the organ, upon each side, the membrane is reflected upon the sublingual gland and the inner surface of the mylo-hyoid muscle near its insertion, and thence to the inner surface of the lower jaw, forming the floor of the

mouth. In front it is extended from beneath the tip of the organ to the inner aspect of the symphysis of the lower jaw, in the form of a tolerably large triangular fold, called the *bridle of the tongue*, upon each side of

Fig. 204.

View of upper surface of tongue. 1, 2, V-like row of circumvallate papillæ; 3, capitate papillæ; 4, 5, conical papillæ; 6, 6, floor of fauces, with numerous simple follicular glands; 7, tonsils; 8, summit of epiglottis; 9, middle glosso-epiglottic frænum, with depressions on each side bounded externally by lateral fræna.

which may be observed the orifices of the ducts of the submaxillary and sublingual glands.

The upper or dorsal surface of the tongue is divided into two lateral halves by a median furrow, and studded with numerous little eminences, called *Gustatory Papillæ*, which diverge from the latter forward and outward. Three varieties of papillæ may be recognized with the naked eye, and are named respectively calyciform, fungiform, and conical.

The *Calyciform Papillæ* (papillæ circumvallatæ), twelve or fifteen in number, are the largest, and situated posteriorly a short distance in front of the epiglottis, where they are arranged in two rows like the letter V with its point presenting backward. Each one is shaped like an inverted cone, and attached by its apex to the bottom of a cuplike depression or calyx.

The *Fungiform Papillæ* (papillæ capitatæ), the next in size, are scattered over the whole of the surface, but are most numerous near the tip of the organ. They are of a rounded form, deep-red color, and attached by a narrow pedicle.

The *Conical Papillæ* are smaller, but far more numerous, and are thickly set over the whole surface of the tongue in front of the calyciform group.

Covering the exterior of the papillæ of taste, and crowded in the interstices between them, are numberless little conical eminences, called *Simple Papillæ*, which cannot, however, be seen except with the aid of a magnifying-glass. Those which are found upon the calyciform and fungiform papillæ terminate in blunt extremities, but on the conical variety they terminate in long hairlike processes of epithelium, which give to the surface of the tongue its velvety character. Their appearance is well represented in the accompanying figure.

Fig. 205.

Papillæ of tongue, highly magnified. 1, conical papillæ; 2, capitate papillæ; 3, simple papillæ, occupying intervals of compound papillæ; 4, epithelium ascending from conical papillæ in hairlike processes; 5, isolated epithelial scales from latter.

Behind the papillæ, upon the root of the organ, are a number of large mucous follicles, readily distinguished by their circular orifices. A number of them open together in a little pouch behind the middle calyciform papillæ.

Structure.—The substance of the tongue consists of animal muscular tissue, and a variable quantity of adipose substance. The muscular fibres are either intrinsic or extrinsic—that is, they belong exclusively to the organ, or are derived from surrounding muscles. The *intrinsic fibres* are longitudinal and transverse; the former constitute two layers attached behind to the body of the hyoid bone, from which they pass forward to the tip of the organ and inclose the transverse. The *extrinsic fibres* are continuations of the various muscles that are inserted into the under surface of the organ, and are intimately blended with the former.

The *arteries* of the tongue are the *ranine* or lingual (one upon each side), branches of the facial. The *nerves* are derived from three sources; the fifth or trigeminal supplies the mucous membrane and papillæ of the forepart and middle of the organ; the glosso-pharyngeal is distributed upon its back part and the contiguous fauces, but also sends a branch forward to the under surface of the tip; the hypoglossal or lingual supplies its muscular tissue throughout. The glosso-pharyngeal and lingual or gustatory branch of the fifth endow the organ with its special sense, the sense of taste, which is generally supposed to be only a modification of ordinary sensation; the hypoglossal is a simple motor nerve.

THE PHARYNX.

Dissection.—Having removed the muscles, vessels, and nerves from both sides of the neck, divide the trachea and œsophagus about an inch below the larynx, and turn them upward from the front of the spine as far as the base of the skull; then apply a saw flatwise, and as close as possible to the front of the spine, and divide the skull vertically upward. Cleanse the parts well, and stuff the mouth and pharynx with curled hair or moss, to facilitate the dissection of the muscles of the latter.

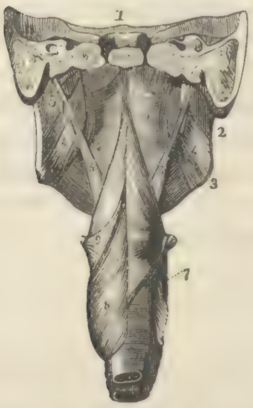
The Pharynx is a musculo-membranous pouch, situated in the middle line of the upper part of the neck, immediately below the basilar process of the occipital bone, and in front of the cervical vertebræ. It is separated from the latter by the anterior straight muscles of the head, to the anterior surface of which it is attached by rather loose areolar tissue. Laterally, it is in relation, above, with the internal pterygoid muscle, internal carotid artery, glosso-pharyngeal, hypoglossal, and spinal accessory nerves; below, with the external carotid artery and its branches, and numerous lymphatic glands; and, in its whole length, with the internal jugular vein and pneumogastric nerve. In front it is attached to the pterygoid processes of the sphenoid bone, the pterygo-maxillary ligament, molar ridge of the lower jaw, hyoid bone, thyroid and cricoid cartilages, and upper rings of the trachea. Its lower extremity is continuous with the commencement of the œsophagus opposite the fifth cervical vertebra.

The walls of the pharynx consist of three membranous muscles, a strong fibrous layer, and a lining of mucous membrane. The muscles, called,

from their action, constrictors, are external, and should be examined first, and may be exposed by carefully removing the areolar tissue from the posterior surface of the pharynx, the cavity being stuffed as before directed.

The **Inferior Constrictor Muscle** (Figs. 206, 8, and 207, 9), the posterior and lowest of the three, arises, upon each side, from the two upper rings of the trachea and the lateral surfaces of the cricoid and thyroid cartilages; it curves upward and backward, overlapping the lower half of the

Fig. 206.



Posterior view of muscles of pharynx. 1, vertical section carried transversely through base of skull; 2, posterior border of ramus of lower jaw; 3, angle of inferior maxilla; 4, internal pterygoid muscle; 5, styloid process of temporal bone, giving attachment to 6, stylo-pharyngeal muscle; 7, inferior extremity of stylo-pharyngeal muscle attached to superior horn and posterior border of thyroid cartilage; 8, inferior constrictor of pharynx; 9, middle constrictor of pharynx, partly covered on left side by inferior constrictor; 10, superior constrictor of pharynx; 11, external surface of mucous membrane of pharynx, uncovered by muscular fibres.

Fig. 207.

Side view of muscles of pharynx. 1, trachea; 2, cricoid cartilage; 3, crico-thyroid membrane; 4, thyroid cartilage; 5, thyro-hyoid membrane; 6, hyoid bone; 7, stylo-hyoid ligament; 8, œsophagus; 9, inferior constrictor; 10, middle constrictor; 11, superior constrictor; 12, stylo-pharyngeal muscle passing down between superior and middle constrictor; 13, upper concave border of superior constrictor; at this point muscular fibres of pharynx are deficient; 14, pterygo-maxillary ligament; 15, buccinator muscle; 16, orbicular muscle of mouth; 17, mylo-hyoid muscle.

middle constrictor, and is inserted with its fellow of the opposite side into the middle line of the pharynx behind and below.

Dissection.—Dissect the inferior constrictor of one side as represented in Fig. 206, and the next muscle of the same side will be brought wholly into view.

The **Middle Constrictor Muscle**, triangular or fan-shaped, arises from the two horns of the hyoid bone, and the stylo-hyoid ligament, curves backward and spreads outward, and is inserted with its fellow of the opposite side into the upper two-thirds of the middle line of the pharynx

behind, and by a pointed extremity into the basilar process of the occipital bone. It is overlapped below by the inferior constrictor muscle, and overlaps above the lower part of the superior constrictor.

The Superior Constrictor.—This thin and quadrilateral muscle arises from the internal pterygoid plate, the pterygo-maxillary ligament, and the posterior extremity of the lower jaw, curves almost horizontally backward, and is inserted with its opposite fellow into the upper half of the middle line of the pharynx behind, and into the basilar process of the occipital bone.

Use.—The constrictor muscles, as their name imports, diminish the cavity of the pharynx, by which movement, which is only partly under the control of the will, substances received from the mouth are grasped, and then, the pouch being drawn up by the stylo-pharyngeal and the elevator muscles of the larynx and tongue, the mass is forced down into the œsophagus.

Dissection.—Dissect the constrictors carefully aside, and a strong aponeurosis or fascia will be brought into view.

The *Pharyngeal Aponeurosis* is the middle coat of the pouch, and similar in all respects to the fibro-areolar coat of the intestinal canal. It is attached above to the basilar process of the occipital bone, the apex of the petrous bone, and pterygoid processes of the sphenoid, and extends downward between the mucous and muscular layers, becoming thinner as it descends, and is continuous with the fibro-areolar coat of the œsophagus.

Dissection.—Open the pharynx behind by a median incision extending nearly its whole length, and its internal or mucous surface will be exposed, together with the several openings of communication presently to be mentioned.

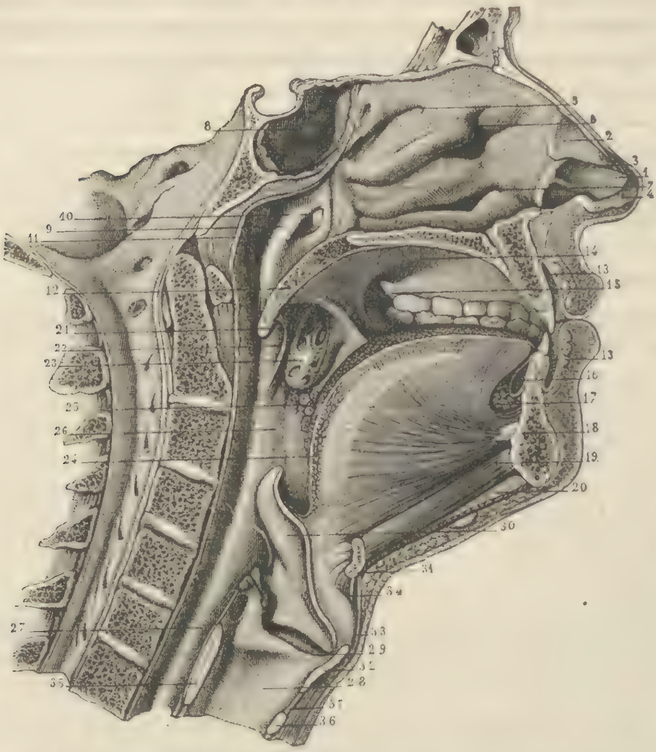
The *Mucous Membrane* of the pharynx is tolerably thick opposite the basilar process of the occipital bone, but becomes thinner and paler lower down. In front of the cervical vertebræ, and opposite the back part of the mouth, it is thrown into a number of vertical folds, and is provided with glands like those of the lips and cheeks. According to Henle, its epithelium is columnar, and ciliated as low down as upon a level with the floor of the nasal cavities; but, below this point, it is squamous.

Vessels and Nerves.—The pharynx is supplied principally by the ascending pharyngeal *artery*, a branch of the external carotid. Its *veins* form a considerable plexus, and open into the internal jugular and superior thyroid vein. The *nerves* are very numerous, and form an intricate plexus between the constrictor muscles. They are branches of the glosso-pharyngeal, pneumogastric, and sympathetic. On account of its large nervous connections, the pharynx is possessed of great sensibility, and of sympathies hardly equalled by any other part of the alimentary canal.

Upon each side above, the pharynx communicates with the ear through the Eustachian tube; in front, with the nasal cavities, mouth, and larynx; and at its inferior extremity with the commencement of the œsophagus.

The **Posterior Nares** are the two large oval openings situated in front

Fig. 208.



Vertical section of face and neck, through median line antero-posteriorly, exposing to view nose, mouth, pharynx, and larynx. 1, oval cartilage of left nostril; 2, triangular cartilage; 3, their line of separation; 4, prolongation of oval cartilage along column of nose; 5, superior meatus of nose; 6, middle meatus; 7, inferior meatus; 8, sphenoidal sinus; 9, posterior part of left nasal cavity, communicating with pharynx; 10, orifice of Eustachian tube; 11, upper extremity of pharynx; 12, soft palate, ending below in uvula; 13, interval of mouth between lips and jaws; 14, roof of mouth, or hard palate; 15. communication of cavity of mouth with interval between jaws and cheek; 16, tongue; 17, fibrous partition in median line of latter; 18, genio-glossal muscle; 19, genio-hyoid muscle; 20, mylo-hyoid muscle; 21, anterior half arch, 22, posterior half arch of palate; 23, tonsil; 24, 25, floor of fauces; 26, 27, pharynx; 28, cavity of larynx; 29, ventricle of larynx; 30, epiglottis; 31, hyoid bone; 32, 33, thyroid cartilage; 34, thyro-hyoid membrane; 35, 36, cricoid cartilage; 37, vocal membrane.

of the upper part of the pharynx, and communicating between this cavity and the nasal fossæ. They are bounded above by the body of the sphenoid bone, laterally by the internal pterygoid plates, and below by the continuation of the hard and soft palate, and separated in the middle line by the posterior edge of the vomer.

The **Isthmus of the Fauces** is the constricted opening communicating with the cavity of the mouth. It is situated beneath the posterior nares, and is bounded, above, by the soft palate and uvula; laterally, by two folds of mucous membrane called the half arches of the palate; and, below, by the root of the tongue.

The **Soft Palate** is a quadrilateral, fleshy, movable partition or valve, situated between the mouth and the pharynx. It forms the extension of the hard palate, from the posterior margin of which it curves downward and backward; and presents for consideration an anterior and a posterior surface, and a free border.

The *anterior* or *inferior surface* is concave, and forms the posterior boundary of the cavity of the mouth; it is marked by a median line or raphe indicating the original union of its two halves. Beneath its mucous membrane, which has a squamous epithelium, are a few glands (palatine glands) similar to those found in the lips and cheeks. The *posterior* or *superior surface* is convex, and forms the continuation of the floor of the nasal fossæ, and part of the anterior boundary of the pharynx; its mucous membrane is covered with a squamous or tessellated epithelium below, but changes to ciliated columnar near the nares. The palatine glands are more numerous upon this than upon the anterior surface.

The *free edge* of the soft palate is thin, and presents in the middle line a small dependent conical process, called the *uvula*. From the base of the uvula the edge curves outward to the lateral boundaries of the fauces, where it forms upon each side two distinct folds, called the *half arches* or *pillars* of the palate; these diverge from above, the anterior passing downward and forward to the side of the tongue, and the posterior downward and backward to the side of the pharynx. They consist of mucous membrane inclosing muscular fibres, and between the two is a triangular excavation which contains the tonsil.

Structure.—The soft palate and uvula are composed principally of muscular tissue, covered by mucous membrane, and provided with racemose glands.

Dissection.—To expose the muscles of the palate, it is necessary to remove carefully the mucous membrane and glands from only the posterior surface of the organ.

The Muscles of the Palate are five in number upon each side; two superior, called the elevator and tensor of the palate; two inferior, named the palato-glossal and palato-pharyngeal; and one in the middle line, called the elevator of the uvula, which forms, with its fellow of the opposite side, the azygos muscle.

The **Elevator of the Palate** (*levator palati*, thick and rounded above and flattened below, arises from the apex of the petrous bone behind the

Eustachian tube, descends along the outer side of the posterior nares, turns inward, and is inserted into the middle of the soft palate beneath the mucous membrane of its posterior surface. Its name indicates its use.

The **Circumflex** or **Tensor Muscle of the Palate** (*tensor palati*), thin and delicate, is seen by removing the preceding, to which it is external. It arises from the scaphoid fossa at the root of the internal pterygoid plate, from the anterior surface of the Eustachian tube, and from the spinous process of the sphenoid bone. It descends, and, ending in a tendon which turns over the hooklike or hamular process of the internal pterygoid plate, is inserted by an expanded fascia into the under surface of the palate process of the palate bone and adjacent part of the soft palate.

The **Elevator** or **Retractor of the Uvula** arises from the spine of the palate bone on each side, descends, and unites with its fellow of the opposite side in the median line of the uvula. The two form what was once considered to be only one muscle, known as the *Azygos Uvulæ.*

The **Palato-glossal Muscle** is contained in the anterior half arch of the palate; it is long and slender, arises from the inferior surface of the soft palate, descends forward, and is inserted into the side of the tongue.

The **Palato-pharyngeal Muscle** is contained in the posterior half arch; it arises from the inferior surface of the soft palate, descends backward, and is inserted into the side of the pharynx.

Uses.—The elevator raises the palate, and is of great use in preventing the passage of food, water, etc. into the posterior nares and Eustachian tube in deglutition and vomiting. The tensor assists the elevator by spreading the palate out, and making it tense. The palato-glossal and palato-pharyngeal narrow the isthmus of the fauces; and, by successive contraction, throw the food into the pharynx. The azygos retracts the uvula.

The **Tonsil**, on each side, is an oval-shaped body about the size of an almond kernel (hence, sometimes called the amygdala), which is situated in the triangular interval between the anterior and posterior half arches of the palate, and forms a slight irregular projection upon the mucous surface. Its free surface is uneven and marked by a number of irregular fissurelike depressions or pouches, which lead to smaller cavities of the same kind, and into the latter open the ducts of the follicles of which the organ is composed. Its deep surface rests upon the internal surface of the superior constrictor muscle of the pharynx and is in almost immediate contact with the internal carotid artery. When the organ is enlarged, as is frequently the case, it presses closely upon this vessel, and is brought into relation also with the external carotid and commencement of the facial artery.

Structure.—The tonsil is a collection of muciparous follicles or crypts, which are held together by areolar tissue and communicate with the throat through the intervention of the little pouches referred to above. It secretes a mucous fluid for lubricating the surrounding parts.

Vessels and Nerves.—The tonsils receive branches from the facial and ascending pharyngeal *arteries.* Their *veins* form a plexus, and terminate in the pharyngeal plexus. Their *nerves* are derived from the glosso-pharyngeal and fifth pair.

THE NOSE AND NASAL CAVITIES.

The Nose.—In its widest signification the term Nose includes the cavities in which the sense of smell resides, but ordinarily it is limited to the so-called feature in the middle of the face. Using the word in its latter restricted sense, the nose is considered as having a root, bridge, tip, and wings, the location of which is familiar to every one. The external openings are called the *anterior nares.*

The fundamental structure of the nose consists of bones and cartilages covered externally by skin and muscles, and periosteum, and lined internally by mucous membrane.

The *Skin* of the nose is thin over the bridge, and loosely attached to the subjacent structures, but approaching the tip and wings it becomes thick and dense, and so closely connected to the cartilages that the slightest effusion between the two, as in erysipelas, produces great tension and intense pain. It is remarkable for the number and large size of its sebaceous glands.

The *Muscles* have been already described (see Muscles of Face).

The *Bones* of the nose are the nasal and the ascending processes of the superior maxillary. The former constitute the bridge, which is supported on each side by the latter, and, in the middle line, by the anterior border of the nasal plate of the ethmoid.

The *Cartilages* of the nose form the movable part of the organ, and consist of five pieces, two upon each side and one in the middle line.

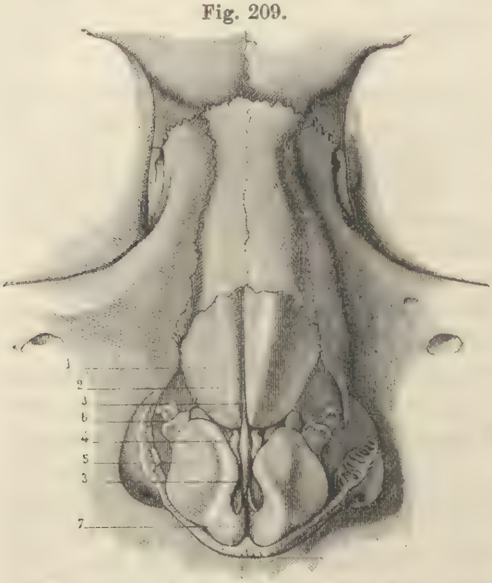
The *lateral cartilages* (Fig. 209) are in pairs, and placed one above the other. The upper pair are somewhat ovoidal, continuous above with the lower border of the nasal bones, and closely connected with each other, and with the anterior edge of the cartilage of the septum in the middle line, by dense connective tissue. The lower pair are very irregular in shape, touch each other in the middle line, where they are supported by the cartilage of the septum, and expand outward to give insertion to the wings. They are attached to the preceding by strong fibrous tissue, which is spread out as far as the ascending processes of the superior

maxillary bone and continuous with the fibrous tissue of the wings. Imbedded in this fibrous tissue are two or three cartilaginous nodules (accessory cartilages) which assist to fill up the angular intervals between the two pairs just described.

The *wings* (alæ nasi) constitute the prominent expanded outer borders of the anterior nares. They are composed of skin and a subjacent layer of tough fibrous tissue, into which are inserted the nasal dilator, elevator, and depressor muscles.

The *cartilage of the septum* (Fig. 210), sometimes called the triangular cartilage of the nose, fills up the angular interval in front of the vomer and nasal plate of the ethmoid. It is continuous behind with the anterior edges of the two bones just mentioned, and supports the opposed borders of the lateral cartilages in front, extending upward as far as the junction between the nasal bones. Its lower border is covered by integument and forms the *pillar*, which separates the anterior nares. Its lateral surfaces are covered by the mucous lining of the nasal cavities, a fibro-vascular membrane intervening.

Fig. 209.



Cartilages of nose. 1, upper lateral cartilage; 2, its anterior border; 3, anterior margin of cartilage of septum appearing between lateral cartilages; 4, small accessory cartilage; 5, lower lateral cartilage, back of which is wing of nose; 6, accessory cartilages; 7, tip of nose where lower lateral cartilages are bent inwardly along column.

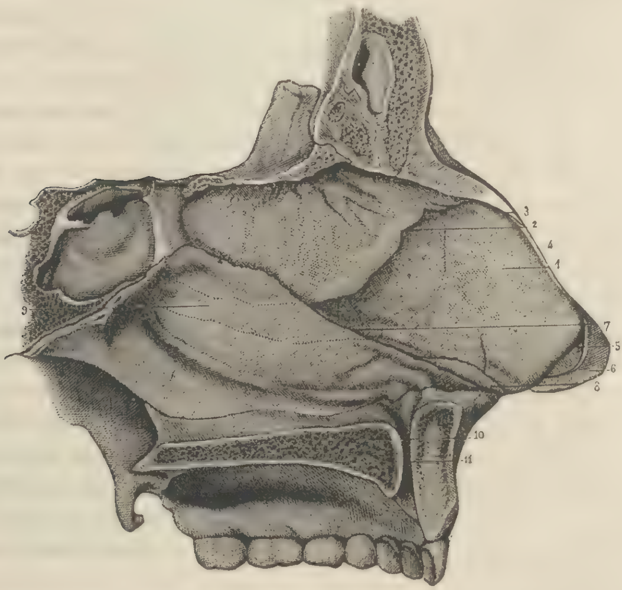
The *Anterior Nares* are the two oval openings communicating between the nasal cavities and the external air. They are bounded externally by the wings, and separated in the middle line by the pillar or column of the nose. Within the orifices the skin becomes continuous with the mucous membrane of the nasal cavities, and is set with numerous short stiff hairs.

The Nasal Cavities.—The Nasal Fossæ are the two large fissurelike passages situated in the middle line of the face, and extending from the anterior nares in front to the pharynx behind. They are separated from each other by the nasal septum, which is formed above by the nasal plate of the ethmoid bone, below and behind by the vomer, and in front by the

cartilage of the septum. Each cavity has a floor, a roof,and two lateral walls.

The floor of the nasal cavity is horizontal and formed by the palate processes of the superior maxillary and palate bones, and by the soft palate. The roof is arched and is composed of the nasal cartilages and nasal bones in front, the cribriform plate of the ethmoid bone above, and the body of the sphenoid behind. The internal wall is formed by the nasal septum, which is not always in the middle line, but often bent to one side or the other. The external wall is very irregular, and traversed

Fig. 210.



Septum of nose. 1, cartilage of septum; 2, its junction with nasal plate of ethmoid bone; 3, its junction with nasal bones; 4, margin of continuation with upper lateral cartilage; 5, fibrous membrane connecting cartilage of septum with lower lateral cartilage; 6, inner portion of left lower lateral cartilage; 7, anterior border of vomer; 8, accessory cartilage; 9, prolongation of cartilage of septum, in groove between vomer and nasal plate of ethmoid; 10, naso-palatine canal of right side opening into 11, anterior palatine foramen.

from before backward by the three turbinate bones and the three intervening grooves called the meatuses. These parts having been minutely described in connection with the bones of the face, it is only necessary here to point out the modifications produced by the presence of the lining membrane.

The mucous membrane lining the nasal cavities, and called the *pituitary* or *Schneiderian* membrane, follows the irregularities of the bony surfaces upon which it rests, and is prolonged through the several communicating apertures into the frontal, ethmoidal, sphenoidal, and maxillary

sinuses. The extent of its free surface is therefore very great, and accounts for the abundant secretion which it furnishes when in a state of congestion. It is, moreover, continuous through the nasal and lachrymal ducts with the conjunctiva of the eye, through the anterior nares with the skin of the face, and through the posterior nares with the lining membrane of the pharynx. It is remarkably vascular, but varies in this respect, and in its color and thickness, in different situations. It is thickest and most vascular upon the turbinate bones and septum, and here it presents a bright-red color, but in the sinuses it is thin and transparent. Its epithelium is columnar ciliated, except near the anterior nares, where it is squamous.

Beneath the mucous membrane is the periosteum, a fibro-vascular membrane, which, in the nasal cavities proper, is a thick consistent structure, but in the sinuses comparatively thin and much less vascular.

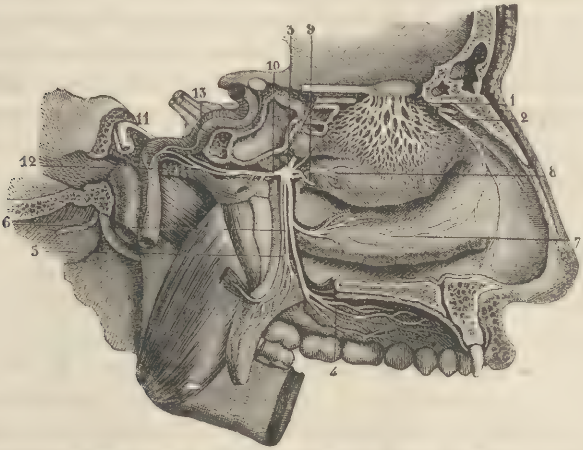
By means of the mucous membrane, some of the foramina, communicating with the nasal cavities in their skeleton state, are entirely closed, and the others are materially lessened in size. Thus, in the superior meatus, the openings leading into the posterior ethmoidal cells and sphenoidal sinus are very much narrowed, and the large spheno-palatine foramen entirely closed. In the middle meatus, the funnel-shaped entrance leading to the anterior ethmoidal cells, and through them to the frontal sinus, is almost concealed from view by an overhanging fold of the mucous membrane; and, farther back, the opening of the antrum is reduced to the size of a crowquill, and partly overhung by a circular fold of the same. In the inferior meatus, the terminal opening of the nasal duct is rendered valvular by two projecting folds of the lining membrane, which act as a sort of valve to prevent the passage of the air in this direction, and offer a serious obstacle to the introduction of a probe or catheter from below. The openings in the cribriform plate of the ethmoid bone are alsocovered in.

Vessels and Nerves.—The vessels of the pituitary membrane are very numerous. Its *arteries* are principally offsets from some of the subdivisions of the internal maxillary; one of them, although not very large, of more practical importance than the others, is the *artery of the septum*, which comes from the spheno-palatine, and descends forward, upon each side of the septum, nearly as far as the anterior nares, and sends branches to all the surrounding parts. The *veins* form an extended plexus between the mucous and fibrous layers, and communicate principally with the facial and ophthalmic veins; those from the roof of the cavity communicate also, through the cribriform plate of the ethmoid bone, with the veins within the cranial cavity.

The *nerves* of the pituitary membrane are derived from the first and fifth pairs. Upon the former depends the sense of smell, and upon the latter common sensibility.

The first or olfactory nerve, as heretofore seen, is contained within the cavity of the cranium, and it forms a bulbous enlargement, which rests upon the upper surface of the cribriform plate of the ethmoid bone.

Fig. 211.



View of spheno-palatine ganglion, outer wall of left nasal cavity, and olfactory nerve. 1, olfactory nerve; 2, nasal branch of ophthalmic nerve; 3, spheno-palatine ganglion; 4, 5, 6, palatine nerves; 7, branch to nose; 8, nasal nerve to outer wall of nose; 9, nasal nerve to inner wall; 10, pterygoid nerve; 11, facial nerve; 12, deep petrous nerve, joining carotid plexus 13; other branch of pterygoid is larger petrosal nerve, which joins facial.

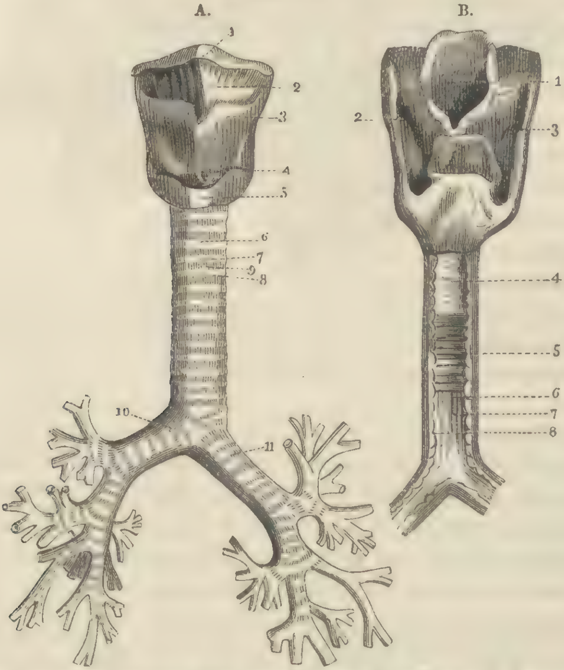
From the under surface of the bulb numerous branches are given off, which traverse the foramina in the plate, and divide into two sets, one for the septum, and the other for the outer wall of the nasal cavity; these descend at first between the mucous and fibrous layers in delicate grooves upon the bony surfaces, and then form intricate plexuses in the substance of the mucous membrane. The branches that go to the septum are somewhat larger than the others, and are distributed as low down as the inferior third or fourth of this structure, and those which supply the membrane upon the external wall may be traced as low as the inferior border of the middle turbinate bone, but no lower. From this, it may be inferred that the olfactory sense resides only in that portion of the mucous membrane which invests the upper two-thirds of the lateral walls of the proper nasal cavities.

The nerves which confer general sensibility upon the membrane are the nasal branches of the spheno-palatine ganglion, a branch from one of the palatine nerves, and the internal nasal division of the ophthalmic nerve—all of them branches of the trifacial or fifth pair.

THE LARYNX.

The Larynx is the special organ of voice. It is situated over the commencement of the trachea or windpipe, in the upper forepart of the neck, in front of the lower part of the pharynx, and below the hyoid bone and root of the tongue. It consists of a jointed cartilaginous framework, special muscles for the movement of its several pieces, two peculiar ligaments called the vocal cords, and an inclosed cavity communicating with the pharynx and trachea, and lined by a mucous membrane.

Fig. 212.



A. Larynx, trachea, and bronchial tubes, viewed in front. 1, hyoid bone; 2, thyro-hyoid membrane; 3, thyroid cartilage; 4, crico-thyroid membrane; 5, cricoid cartilage; 6, trachea; 7, 8, two cartilaginous rings; 9, membrane which separates them; 10, right bronchus and its divisions; 11, left bronchus.

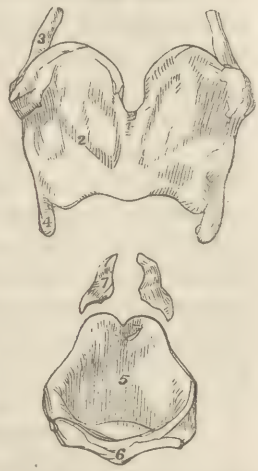
B. Larynx, trachea, and commencement of bronchial tubes, viewed from behind. 1, upper opening of larynx; 2, 3, lateral grooves of larynx; 4, fibrous membrane of trachea, interspersed with small glands, beneath which are seen 5, muscular fibres; beneath this last are 6, 7, small fibrous bands; 8, mucous membrane seen between them.

Cartilages of the Larynx.—The number of separate cartilaginous pieces entering into the structure of the larynx is nine, of which four form the skeleton or framework of the organ properly so called, namely, the thyroid, cricoid, and two arytenoid. The remaining three are the valve, which covers the entrance to the cavity of the organ, and hence called the epiglottis, two minute pieces situated in the adjacent mucous membrane,

named from their shape the cuneiform cartilages, and two little cartilaginous nodules appended to the arytenoid and called the cornicula.

The *Thyroid Cartilage* (Fig. 212, $_3$), the largest of the set, is symmetrical, and consists of two flaring quadrangular plates or wings, united at an acute angle in front, and inclosing a large wedge-shaped space, in which nearly all of the other parts of the organ are situated. The anterior edge, formed by the union of the two lateral plates, is more prominent above than below, and lies just beneath the skin, in the middle line of the forepart of the neck, where it forms the projection commonly known as *Adam's apple* (pomum Adami). The *external surface* of each plate is somewhat uneven, and marked near its inferior posterior corner by an indistinct oblique ridge, directed from behind downward and forward, which gives attachment to the sterno-thyroid muscle below, and the thyro-hyoid above. The small space below this line gives origin to part of the inferior constrictor of the pharynx, and the larger space above is covered by the sterno-thyroid muscle. The *internal surface* is smooth and concave, and in relation with the other parts presently to be described. The *superior border* is shaped somewhat like the italic letter *f*; it forms, with its opposite fellow, a considerable notch in front, and is connected throughout by a strong fibrous membrane (thyro-hyoid membrane) to the hyoid bone. The *inferior border*, shorter than the superior, and less irregular, is connected in front to the upper edge of the cricoid cartilage by the crico-thyroid membrane, and gives attachment on each side to the crico-thyroid muscle. The *posterior border* is thick and rounded, and prolonged above and below into two considerable processes called the *horns* (cornua) of the thyroid cartilage, of which the superior is the longer, and connected to the greater horn of the hyoid bone by the thyro-hyoid ligament, and the inferior thicker and shorter, and articulated at its extremity with the side of the cricoid cartilage.

Fig. 213.



Cartilages of larynx separated and seen in front. 1 to 4, thyroid cartilage; 1, vertical ridge, commonly called Adam's apple, formed by union of two plates or rings; 2, right ring; 3, superior, and 4, inferior horn of right side; 5, 6, cricoid cartilage; 7, right arytenoid cartilage.

The *Cricoid Cartilage* (Fig. 213, $_5$) is ring-shaped, but, owing to the obliquity of its superior border, is higher behind than in front, measuring nearly an inch in length in the former situation, and only about two lines and a half in the latter. Its anterior narrow surface is subcutaneous in the middle line of the neck below Adam's apple, and upon each gives origin to the crico-thyroid muscle; a little farther removed externally is

a small tubercle that articulates with the inferior horn of the thyroid cartilage. The posterior surface is rough, and marked in the middle line by a ridge which separates two superficial fossæ that lodge the posterior crico-arytenoid muscles. The superior border is very oblique from behind downward and forward. In front, it is separated from the lower border of the thyroid cartilage by a transversely oval-shaped interval, occupied by the crico-thyroid membrane; externally, it is crossed by the lower edge of the thyroid cartilage, and gives origin to the lateral crico-arytenoid muscles; behind it is marked by a slight notch, upon the sides of which are two smooth convex facets for articulation with the arytenoid cartilages. The inferior border is horizontal, and connected to the upper edge of the first ring of the trachea. The interior of the cricoid cartilage is smooth, and lined by a fibro-mucous membrane.

The two *Arytenoid Cartilages* are irregularly triangular pyramidal in shape, from five to six lines in length, three lines in width, and little more than a line in thickness. They are articulated by their bases to the highest part of the superior border of the cricoid cartilage behind, are parallel, but separated by a narrow interval, and bent a little backward at their tips. The *surfaces* of each are rough for the attachment of muscles; except the internal and narrowest surface, which presents toward its fellow, and is covered only by the mucous membrane. The *base* is slightly excavated, and near its inner part presents a smooth articular facet. The anterior of the angles of the base is very prominent, and gives attachment to the posterior extremity of the vocal cord; the external, short and rounded, gives insertion to the posterior and lateral crico-arytenoid muscles. The apex or summit of each cartilage forms a blunt point, to which is appended the corresponding corniculum.

The *Cornicula* are two very small cartilaginous nodules appended to the summits of the arytenoid cartilages.

The *Cuneiform Cartilages* are two very small wedge-shaped cartilaginous bodies found in the fold of the mucous membrane, which extends from the summits of the arytenoid cartilages to the sides of the epiglottis.

The *Epiglottis* is a thin flexible plate of fibro-cartilage, shaped somewhat like a cordate leaf, the stem or pedicle of which is attached to the retreating angle of the thyroid cartilage. It is situated upon the base of the tongue, to which it is intimately connected by mucous membrane, and, in the quiescent state of the part, stands vertically upward in front of the superior opening of the larynx. Its anterior surface is convex, and is connected to the surface of the tongue, upon which it rests, by three little folds or bridles of mucous membrane, of which the middle is the largest. The posterior surface is free, concave from side to side, and pitted by the orifices of numerous little racemose glands. Its superior edge is convex and free, and may sometimes be seen in examinations of the throat, by forcibly depressing the tongue with a spatula. Its lateral

edges are connected to the summits of the arytenoid cartilages by two large folds of mucous membrane which pass directly backward. The office of the epiglottis is to cover the entrance to the larynx in swallowing, which it does more by the elevation of the latter than by its own depression.

Ligaments and Articulations of the Larynx.—The thyroid cartilage is connected to the hyoid bone by two ligaments and a broad membrane. The *thyro-hyoid ligaments* are two rounded fibrous cords, extending from the greater horns of the hyoid bone to the superior horns of the thyroid cartilage. The *thyro-hyoid membrane* consists of several superimposed fibro-elastic laminæ, attached above to the posterior edge of the hyoid bone, and below to the whole length of the superior border of the thyroid cartilage, and continues by its lateral borders with the thyro-hyoid ligaments.

The cricoid cartilage is attached to the upper border of the first ring of the trachea by a fibrous membrane, similar to that which connect the rings of this tube to one another, and by the lining mucous membrane.

The ligaments that connect the several pieces of the larynx together—called *intrinsic*, to distinguish them from the preceding, which are *extrinsic*—are numerous, and many of them quite small.

The ligaments that connect the cricoid and thyroid cartilages are two capsular and one membranous. The capsular ligaments (*crico-thyroid ligaments*) surround the little diarthrodial articulations that exist between the inferior horns of the thyroid cartilage and the outer surface of the cricoid cartilage. They are lined by a synovial membrane, and are similar in all respects to the capsular ligaments of the joints of the skeleton. The *crico-thyroid membrane* is a strong fibro-elastic lamella, which closes the interval between the thyroid and cricoid cartilages in front. It is transversely oval, and is said to be continuous at its outer extremities with the lower margins of the vocal cords. This membrane is subcutaneous in front, but covered laterally by the crico-thyroid muscle; it is perforated by minute arteries and veins, and lined internally by the mucous membrane of the larynx. It is through this membrane that the operation of laryngotomy is performed.

Each arytenoid cartilage is articulated to the cricoid by a regular ball-and-socket joint, having considerable latitude of motion. The two are united by an imperfect capsular ligament surrounding the joint, and by a small but strong flattened fibrous band, called the *posterior crico-arytenoid ligament*, which is attached by one extremity to the base of the arytenoid cartilage behind, and by the other to the back part of the cricoid cartilage.

Interior of the Larynx.—The cavity of the larynx is of a peculiar and very irregular form, and cannot, possibly, be understood except by

actual examination. It communicates above with the pharynx by a large triangular opening, the *Entrance of the Larynx*, bounded in front by the epiglottis, and laterally by two large folds of mucous membrane, that stretch from the summits of the arytenoid cartilages to the margins of the epiglottis, and are hence called the aryteno-epiglottidean folds. Below this point the cavity rapidly narrows to the vocal cords, where, by their close apposition, it is contracted into a mere chink or fissure, somewhat wedgelike or triangular in form, its base presenting backward, and its apex forward. The narrow part of the cavity of the larynx, immediately above the vocal cords is called the *Glottis*,* and the narrow slit between the vocal cords, the *Rima of the Glottis.* Below the rima the cavity again expands, and at the lower circumference of the cricoid cartilage is circular.

Upon an antero-posterior vertical section of the larynx, like that represented in Fig. 198, the following structures are met with, commencing above: 1, the free border of the aryteno-epiglottidean fold; 2, the large oval-shaped surface of the latter, interesting as being the principal seat of œdema in acute laryngitis; 3, the thyro-arytenoid fold of mucous membrane, called also the superior or false vocal cord, which stretches between the retreating angle of the thyroid cartilage and base of the arytenoid cartilage; 4, a long narrow antero-posterior crevice, leading outward to the cavity called the ventricle of the larynx; 5, the vocal cord properly so called, stretched from the base of the arytenoid cartilage to the retreating angle of the thyroid cartilage; 6, the concave surface of the lateral wall of the cricoid cartilage.

The *Vocal Cords* (inferior or true vocal cords) are the sounding strings, by which the voice is mainly produced. They consist of parallel fibres of elastic tissue, collected upon each side into a narrow band, which stretches from the prominent rounded anterior angle of the base of the arytenoid cartilage horizontally forward, to the middle of the entering angle of the thyroid cartilage. They are covered by mucous membrane, form upon each side the lower margin of the opening of the ventricle, and are continuous externally with the crico-thyroid membrane, of which they are sometimes considered as the internal free edge.

The *Rima of the Glottis* is the narrow chink or cleft between the vocal cords. It is lancet-shaped, its pointed extremity presenting forward, and measures in the adult male from two-thirds to three-fourths of an inch in length. Its breadth is greatest behind, but varies with the position of the arytenoid cartilages.

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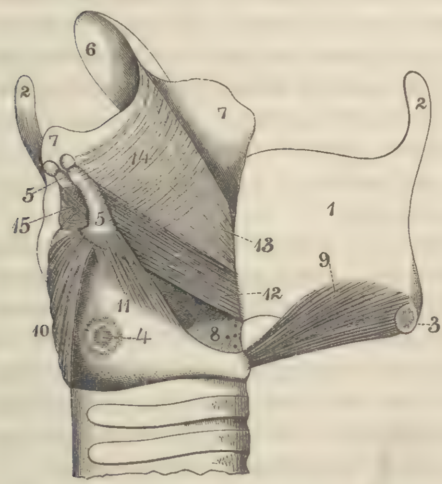
* The term glottis is variously employed; some writers apply it to the large triangular opening communicating with the pharynx, and some to the circumference of the cavity at the rima. The author prefers to follow Quain, in limiting its application to the narrow part of the cavity immediately above the rima.

The *Ventricles of the Larynx* are the two flattened oblong cavities situated beneath the mucous membrane of the lateral walls of the glottis. They lead from the narrow elliptical opening between the true and false vocal cords, in an outward and upward direction, and are comparatively small in the human subject, but very large in some of the inferior animals.

From the anterior part of each ventricle a narrow opening leads to a small conical cavity, called the *laryngeal pouch,* which extends outward beneath the mucous membrane, as far as the superior border of the thyroid cartilage, and forward as far as the lateral margin of the epiglottis. It is lined by a prolongation of the mucous membrane, surrounded by a quantity of adipose tissue, an imperfect fibrous covering, and a few scattered muscular fibres. A large number of little racemose glands communicate with its interior.

Muscles of the Larynx.—The muscles of the larynx are extrinsic and intrinsic; that is, they act upon the organ as a whole, or upon its individual pieces. The former have been already described with the other muscles of the neck; they are the sterno-hyoid, sterno-thyroid, omo-hyoid, thyro-hyoid, stylo-hyoid, etc. The intrinsic consists of four pairs, and a single muscle; those in pairs are the crico-thyroid, posterior crico-arytenoid, lateral crico-arytenoid, and thyro-arytenoid; the single one is the arytenoid.

Fig. 214.



Muscles of larynx. 1, right half of thyroid cartilage, turned forward; 2, superior horns; 3, inferior horn marked by crico-thyroid articulation; 4, other portion of latter on side of cricoid cartilage; 5, arytenoid cartilages, surmounted by nodules of same substance; 6, epiglottis; 7, two laminæ of aryteno-epiglottic fold separated to expose muscles; 8, lower part of vocal membrane; 9, crico-thyroid muscle; 10, posterior crico-arytenoid muscle; 11, lateral crico-arytenoid; 12, thyro-arytenoid; 13, thyro-epiglottic muscular fibres; 14, aryteno-epiglottic muscular fibres; 15, arytenoid muscle.

The *Crico thyroid Muscle* (Fig. 214, 9), short, thick, and triangular, arises from the anterior surface of the cricoid cartilage, a little external to the median line, ascends obliquely outward along the outer limits of the crico-thyroid membrane, and is inserted into the external third of the lower border of the thyroid cartilage, and into the anterior margin of the inferior horn of the same.

The *Posterior Crico-arytenoid Muscle*[10] occupies the superficial

depression upon the posterior surface of the cricoid cartilage, by the side of the median ridge. It is flattened, triangular, and of a bright-red color ; arises from the whole of the surface upon which it is situated, ascends, its fibres converging, and is inserted by a narrow extremity into the external angle of the base of the arytenoid cartilage.

The *Lateral Crico-arytenoid Muscle*,[11] smaller than the preceding, and of an oblong figure, arises from the upper border of the cricoid cartilage in front, and on the outer side of the crico-arytenoid articulation, ascends obliquely backward, and is inserted into the external angle of the base of the arytenoid cartilage.

The *Thyro-arytenoid Muscle*,[12] broad and thin, arises in front from the lower half or two-thirds of the retreating angle of the thyroid cartilage, passes horizontally backward, below and along the outer border of the vocal cord, and is inserted into the base, and contiguous outer border of the arytenoid cartilage.

The *Arytenoid Muscle*[15] occupies the narrow interval between the two arytenoid cartilages, and consists of oblique and transverse fibres. It arises from the outer border and posterior surface of the arytenoid cartilage, and is inserted into the corresponding parts of its opposite fellow.

Besides the nine separate muscles above described, modern anatomists have demonstrated the existence of muscular fibres in other parts of the larynx. They may be arranged in three groups: 1. *Thyro-epiglottic fibres*, which ascend from the thyro-arytenoid muscles, and are inserted into the lateral margins of the epiglottis. 2. *Superior aryteno-epiglottic fibres*, which extend from the summits of the arytenoid cartilages to the borders of the epiglottis, inclosed in the folds of mucous membrane that form the lateral boundaries of the large triangular entrance of the larynx. 3. *Inferior aryteno-epiglottic fibres*, which arise from the arytenoid cartilage immediately above the attachment of the vocal cords, pass forward, spread out upon the upper surface of the laryngeal ventricles and pouches, and are inserted into the lateral margins of the epiglottis. These three sets of fibres cannot always be clearly demonstrated in the human larynx, but are very evident in some of the inferior animals.

Actions.—The actions of the intrinsic laryngeal muscles are complicated, and in some instances obscure. The *crico-thyroid* approximate the two cartilages between which they are placed, and assist in making the vocal cords tense by advancing the thyroid cartilage. The *posterior crico-arytenoid* dilate the rima and the cavity of the organ above, and at the same time tighten the vocal cords. The *lateral crico-arytenoid* rotate the arytenoid cartilages inward, so as to approximate and tighten the vocal cords. The *thyro-arytenoid* approximate the thyroid and arytenoid cartilages, and rotate the latter inward, thus tightening and approximating the vocal cords, and, at the same time, diminishing the rima in an antero-posterior direction. The *arytenoid* approximates the

arytenoid cartilages and rotates them outward, by which means the vocal cords are at first relaxed and then tightened and separated, while the cavity above is diminished transversely.

The *thyro-epiglottic fibres* draw down the epiglottis and increase the lateral concavity of its posterior surface. The *superior aryteno-epiglottic* approximate the epiglottis and arytenoid cartilages, and relax the aryteno-epiglottic folds of mucous membrane. The *inferior aryteno-epiglottic* draw the epiglottis backward and downward, and compress the laryngeal ventricles and pouches.

The **Mucous Membrane** of the larynx is continuous above with that of the mouth and pharynx, and below with that of the trachea. Traced from above, it will be found reflected from the upper surface of the tongue behind to the anterior surface of the epiglottis, forming the three glosso-epiglottic bridles (*fræna*) and two intervening pouches or depressions already described; it covers the posterior surface of the epiglottis, and from the lateral margins of this organ extends backward to the cornicula and summits of the arytenoid cartilages in the form of two large folds (aryteno-epiglottic or epiglottidean), which form the lateral borders of the entrance to the larynx. Across the summits of the arytenoid cartilages it forms a short crescentic border, which is the posterior limit of the entrance to the superior opening.

From these points, it descends into the cavity of the larynx, forming upon each side a large oval fossa, and, below this, the thyro-arytenoid fold or false vocal cord. It then lines the laryngeal ventricles and pouches, passes over the true vocal cords, and spreads out upon the inner walls of the cavity below. It is of a pale pink color, varies in thickness at different points, and is covered by a columnar ciliated epithelium. Its attachment to the subjacent parts takes place by means of areolar tissue, which before the age of puberty is short and close throughout, but in the adult becomes loose and open in certain situations, particularly in the oval fossæ beneath the aryteno-epiglottic folds; hence, the greater danger of acute laryngitis in adults from œdema of the glottis. Over the vocal cords the membrane is exceedingly thin and delicate, and most closely adherent.

The laryngeal mucous membrane is largely provided with mucous crypts or glands. They are most abundant upon the epiglottis and in the laryngeal pouches; but are entirely wanting upon the surface and in the immediate neighborhood of the vocal cords.

Vessels and Nerves of the Larynx.—The *arteries* of the larynx are small branches of the superior and inferior thyroid arteries. The *veins* follow the course of the arteries. The *nerves* are the two superior and two inferior laryngeal branches of the pneumogastric, and filaments from the sympathetic. The superior laryngeal nerve (Fig. 203, $_6$) leaves the

pneumogastric just below the base of the cranium, descends forward, sends a branch to the inferior constrictor of the pharynx, crico-thyroid muscle, and thyroid body, then perforates the thyro-hyoid membrane just above the superior border of the thyroid cartilage, and is distributed to the mucous membrane of the larynx. The inferior or recurrent laryngeal nerve (Fig. 203, $_9$) of the right side winds around the subclavian artery; that of the left, around the arch of the aorta: they ascend along the groove formed by the juxtaposition of the trachea and œsophagus, to which they furnish branches, enter the larynx behind, and are distributed to all the muscles except the crico-thyroid.

Changes in the Larynx.—In early life, the larynx is very small and rounded, and does not differ materially in the two sexes. About the age of puberty, however, it undergoes a rapid increase in size, involving in the male a change also in its figure. The increase in the male is about double the original size of the organ, and, in the female, about one-third. In the latter, the original rotundity of the organ is not altered by its increase in size; but in the male it becomes more angular, and forms the prominence in the upper part of the neck commonly known as *Adam's apple.*

The student should now proceed to the dissection of the deep muscles of the neck.

DEEP MUSCLES OF THE NECK.

The Deep Muscles of the Neck consist of six pairs. They are the long cervical muscle, the great and small anterior straight muscle of the head, the lateral straight muscle of the head, and the anterior and posterior scalene muscles.

The **Long Cervical Muscle** (*longus colli*) is long and narrow, and divided below into three fleshy slips. It arises from the bodies of the four lower cervical and three upper dorsal vertebræ, and the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, ascends upon the front of the spine, and is inserted by small tendons into the anterior tubercle of the atlas and the transverse processes of the third and fourth cervical vertebræ.

Use.—To bend the neck laterally, and to assist in rotating the atlas upon the axis; or, if both muscles act, to bend the neck forward.

Relations.—Posteriorly, with the front of the cervical vertebræ, and, anteriorly, with the pharynx, œsophagus, internal carotid artery, jugular vein, pneumogastric and great sympathetic nerves.

The **Large Anterior Straight Muscle of the Head** (*rectus capitis anticus major*), long and flat, arises from the anterior tubercles of the

transverse processes of the four lower cervical vertebræ, ascends nearly vertically, and is inserted into the basilar process of the occipital bone.

Use.—To flex the head forward.

Relations.—The same as the preceding.

The **Small Anterior Straight Muscle of the Head** (*rectus capitis anticus minor*), very short and small, arises from the transverse process of the atlas, and is inserted into the basilar process of the occiput.

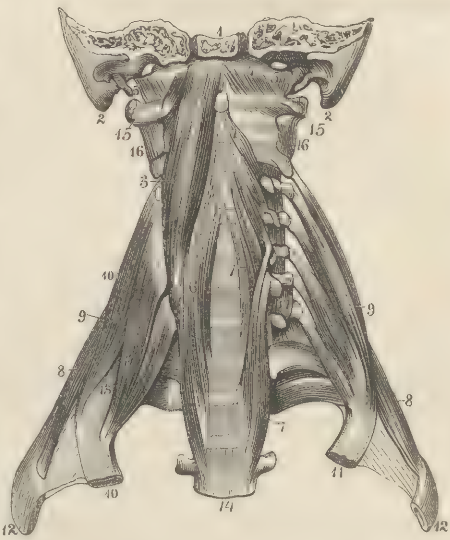
Use.—The same as the preceding.

The **Lateral Straight Muscle of the Head** (*rectus capitis lateralis*) is very short, and extends from the upper surface of the transverse process of the atlas to the jugular process of the occipital bone.

Use.—To incline the head laterally.

The **Anterior Scalene Muscle** (already partly described, p. 443) is situated by the side of the spine in the lower part of the neck. It arises by tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, descends a little forward, and is inserted by a narrow flat tendon into a rough eminence upon the upper surface of the first rib near its middle.

Fig. 215.



Deep muscles of front of neck. 1, basilar process of occipital bone; 2, mastoid process; 3, larger straight muscle; 4, smaller straight muscle; 5, lateral straight muscle; 6, 7, long cervical muscles; 8, posterior scalene muscle; 9, anterior scalene muscle; 10, middle scalene muscle; 11, 12, first and second ribs; 13, position at which subclavian artery and axillary plexus of nerves emerge over first rib, between anterior and middle scalene muscles; 14, third dorsal vertebra; 15, atlas; 16, 17, intertransverse muscles.

Relations.—Anteriorly, with the diaphragmatic nerve, transverse cervical and posterior scapular arteries, and subclavian vein; posteriorly with the subclavian artery and brachial plexus of nerves, which separate it from the next muscle.

The **Posterior Scalene Muscle**, longer and larger than the preceding, arises by tendinous fibres from the posterior tubercles of the transverse processes of the four or five lower cervical vertebræ, descends a little out-

ward, and divides into two slips, the anterior of which (sometimes called the middle scalene muscle) is inserted into the upper surface of the first rib behind the groove for the subclavian artery; and the posterior, into the upper edge of the second rib between its tubercle and angle.

Relations.—In front, it is in relation with the brachial plexus of nerves, subclavian artery, and anterior scalene muscle; behind, with the transverse, splenius, and scapular elevator muscles, on the back of the neck.

Action.—The scalene muscles bend the neck forward and laterally, or elevate the first and second ribs.

THE THORAX AND BACK.

Under this head are comprised, anteriorly and laterally, the walls of the Thorax, and, posteriorly, the Back; with all the important parts contained in the inclosed cavity.

THE THORAX.

The anterior and lateral regions will be first described.

ANTERIOR AND LATERAL REGIONS.

The Anterior and Lateral Walls of the Thorax are covered by the skin, superficial fascia, great and small pectoral, and great serrate muscles.

One side should be dissected with special reference to the muscles; and the other, to study the contents of the axilla or armpit.

Dissection.—Carry the arm from the side, so as to put the pectoral muscles upon the stretch, and then, an incision having been already made along the clavicle to the acromion process in the dissection of the neck, the skin should be divided in the median line the whole length of the sternum, and along the lower edge of the great pectoral muscle which forms the prominent anterior margin of the armpit, the latter incision being carried as far as the upper part of the arm. By this means, a triangular flap of skin is marked off, which is to be removed, leaving the fascia on the surface of the muscle. If the subject is a female, one of the breasts may be dissected by making several radiating incisions from the nipple, dissecting off the flaps, and then carefully picking out, and clipping off the little masses of fat and areolar tissue that are generally found between the excretory ducts and lobes of the gland. This is much facilitated if the ducts have been previously injected with tallow or wax.

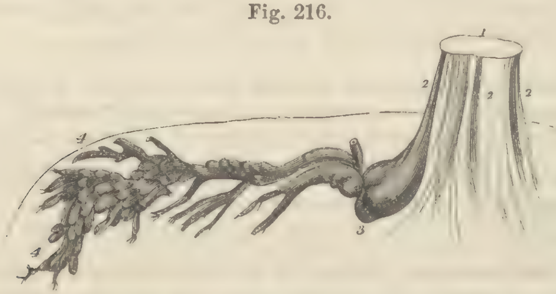
The *Thoracic Fascia*, although not unfrequently dense and strong, is generally thin and of a loose open texture. It may be separated into two distinct layers, the superficial one of which is continuous with the superficial fascia of the neck, and in the female covers the mammary gland; while the deeper one is closely attached to the clavicle and sternum, passes beneath the mamma, covers the surface of the great pectoral muscle, and is continuous below with the aponeurosis of the external oblique muscle of the abdomen.

The Mammary Glands.—The Mammary Glands (*mammæ*), the organs of lactation in the female, are situated upon each side of the anterior

surface of the chest, between the skin and great pectoral muscles, where, together with a large amount of fat, they form the two large hemispherical eminences commonly called the breasts. The base of each breast is slightly oval in an oblique direction from below upward and outward, and extends from the outer border of the sternum to the edge of the armpit, and from opposite the third to the seventh rib. The external surface is convex, and a little below the centre is the conical projection called the *nipple*, upon the apex of which are fifteen or twenty little foramina leading to the milk ducts. The nipple is of a dusky brown color, and surrounding its base is a colored circle called the *areola.* In virgins, the latter is of a bright pink or rosy color, but in women who have borne one or more children it has always a brownish hue. In the neighborhood of the areola are numerous sebaceous follicles, which, during suckling, are very much increased in size; they secrete an oily substance for the protection of the nipple.

Structure.—The large rounded form of the breasts depends upon the presence of a quantity of yellow, firm, consistent fat, which surrounds and fills up the interstices of the gland. The glandular tissue consists of a collection of irregular masses or lobes, fifteen or twenty in number, each surrounded by an investment of fibro-areolar tissue, and provided

Fig. 216.



Single lactiferous duct, after Sir A. Cooper. 1, apex of nipple; 2, 2, 2, straight lactiferous ducts of nipple; 3, saclike dilatation of ducts at base of nipple; 4, 4, origin of ducts in substance of gland.

with an excretory duct. The lobes are subdivided by prolongations of the fibrous covering into small lobules, and these consist of minute blind vesicles, which are the terminal extremities of the divisions of the excretory ducts.

From the vesicles the minute canals proceed to form the excretory ducts, which converge toward the base of the nipple, where they become slightly dilated, and then continue on, separate, but closely connected by areolar tissue, to their minute terminal orifices upon the summit of the organ. The walls of the ducts consist of fibrous tissue, lined by a mucous membrane covered by squamous epithelium, and continuous with the skin of the nipple. The nipple is covered externally with skin marked by numer-

ous wrinkles, and supplied with sensitive papillæ. Internally, it seems to be made up of firm areolar tissue and a large number of vessels surrounding the lactiferous ducts, and is capable of a certain degree of erection.

In the male, the mammary glands are perfect in all their parts, but are only rudimentary, although capable, under continued and often repeated mechanical excitement, of as perfect development as in the female.

Vessels and Nerves.—The breasts are supplied with *arteries* from the intercostals, internal mammary, and thoracic branch of the axillary. The *veins* correspond to the arteries. The *lymphatic* vessels, which are numerous, terminate in the axillary glands, a fact which explains the implication of the latter in certain diseases of the organs. The *nerves* are derived from the cutaneous branches of the intercostals.

Dissection.—Remove the mammary glands and the subjacent fascia, directing the edge of the knife as usual in the course of the muscular fibres underneath.

MUSCLES OF THE ANTERIOR AND LATERAL REGIONS OF THE THORAX.

The **Great Pectoral Muscle** (*pectoralis major*, Fig. 121, 1), large, flat, and irregularly triangular, covers nearly the whole of the anterior superior part of the chest. It arises from the anterior border of the sternal half of the clavicle; from the anterior surface of the sternum, for three-fourths of its extent, its fibres indigitating here with those of its fellow of the opposite side; from the cartilages of the third, fourth, fifth, and sixth ribs; and by a thin fleshy slip from the aponeurosis of the external oblique muscle of the abdomen. From these points the fibres converge in front of the armpit, and are inserted by a flattened tendon, somewhat more than an inch in breadth, into the anterior or external margin of the bicipital groove of the humerus.

That portion of the muscle originating from the clavicle is generally separated from the sternal portion by a narrow areolar interval, and lies parallel to and in close connection with the anterior edge of the deltoid muscle, except near the clavicle, where a small triangular space intervenes. The cephalic vein generally occupies the line of separation between the two muscles, and dips into the triangular interval to reach the axillary vein. The costal portion of the muscle ascends obliquely beneath the sternal, giving to the lower margin of the muscle, where it forms the anterior edge of the axilla, a twisted appearance; it is continuous with the upper part of the tendon of insertion, which, in consequence, presents a crucial arrangement of fibres.

Relations.—The great pectoral is covered throughout by the skin and thoracic fascia, a small portion of the platysma muscle intervening above, and is overlapped slightly at its insertion by the anterior edge of the deltoid. It conceals from view the small pectoral and subclavian muscles, and the numerous structures contained in the axillary cavity.

Use.—When the thorax is the fixed point, and the arm is partly elevated, the united action of all the fibres of the muscle tends to carry the arm forward; but the clavicular portion acting with the deltoid would also raise it, and the costal portion depress it. When the arm is raised and fixed, the muscle assists in dilating the chest or raising the body.

Dissection.—Detach the great pectoral from its origin, reflect it outward, and remove the fascia from the surface of the subjacent muscle.

The **Small Pectoral Muscle** (*pectoralis minor*, Fig. 121, $_6$), long, flat, and somewhat triangular, arises from the third, fourth, and fifth ribs, external to their cartilages, ascends obliquely outward in front of the axilla, and is inserted by short tendinous fibres into the inner side of the extremity of the coracoid process of the scapula.

Relations.—In front, it is in relation with the great pectoral, the superior thoracic vessels crossing between; and behind, with the axillary vessels and nerves. It is also covered at its insertion by the deltoid muscle.

Use.—To draw the shoulder downward and forward, or, when the scapula is the fixed point, to elevate the ribs.

The **Subclavian Muscle** (Fig. 121, $_5$), although belonging as much to the neck as to the chest, is best seen in this dissection. As its name indicates, it is situated beneath the clavicle, and is covered in front by a dense strong fascia, which must be detached from the clavicle and the first rib, before the muscle can be properly examined. It originates from the cartilage of the first rib by a thick round tendon, passes upward and outward, spreads out, and is inserted by fleshy fibres along the under surface of the clavicle nearly as far as the acromion.

Relations.—Above, with the clavicle; below, with the subclavian vessels and brachial nerves; and in front, with the great pectoral muscle, from which it is separated by the above-mentioned aponeurotic layer.

Use.—To depress the shoulder or elevate the chest, according as the rib or clavicle is the fixed point.

Dissection.—Remove the small pectoral and disarticulate the sternal extremity of the clavicle, so as to turn the scapular outward, and thus expose the whole of the succeeding muscle. Next dissect off the remaining skin and fascia from the side of the thorax.

The **Great Serrate Muscle** (*serratus magnus*) is broad and flat, and covers almost the whole of the side of the chest. It arises from the nine superior ribs, except the first, a short distance from their cartilages by as many fleshy slips, of which the lower five or six (Fig. 121, $_4$) indigitate with the heads of the external oblique muscle of the abdomen; the superior three are covered by the great and small pectoral. From these points the muscle curves outward and backward upon the side of the chest, becoming narrower in consequence of the obliquity of its lowermost fibres,

and is inserted into the whole length of the inner lip of the posterior edge of the scapula.

Relations.—By its superficial surface, it is in relation, superiorly, with the axillary vessels and nerves; anteriorly, with the under surface of the pectoral muscles; inferiorly, with the latissimus muscle of the back; and posteriorly, with the subscapular muscle which fills up the subscapular fossa; its deep surface is in close contact with the ribs and external intercostal muscles.

Uses.—1, to draw the scapula downward and forward; 2, if only the lower fibres act, to throw the shoulder back by drawing the point of the scapula forward; and 3, when the scapula is the fixed point, to dilate the chest, or draw the trunk upward and backward. Its action as a respiratory muscle in dilating the thorax is sometimes very powerful, and is particularly well seen in croup and some other instances of difficult respiration, in which the individual is often observed to brace himself against the side of the bed, in order to make the shoulder the fixed point for the action of this as well as the pectoral and latissimus muscles.

The **Intercostal Muscles**, also partly exposed by the removal of the pectorals, may be more satisfactorily seen by dissecting up the anterior portion of the great serrate. As their name implies, they occupy the intervals between the ribs, and are considered as consisting of two sets, an external or superficial and an internal or deep. The *External Intercostals* arise by fleshy and tendinous fibres from the external lip of the lower border of each rib, descend obliquely forward, and are inserted into the upper border of the rib below. They extend in a horizontal direction from the transverse processes of the dorsal vertebræ to within a short distance of the costal cartilages, the anterior deficiency being made up by an aponeurosis which is prolonged as far as the sternum. The *Internal Intercostals* may be seen by removal of the preceding, beneath which they are situated, or, better, after the removal of the lungs, by tearing off the costal pleura. They originate from the internal lip of the lower border of each rib, and are inserted into the inner edge of the border of the rib below; the fibres cross those of the external set from above downward and backward, and each muscle extends in a horizontal direction from the sternum to the angles of the ribs.

Relations.—The external intercostals are in relation externally with the several muscles that cover the surface of the chest, and internally with the internal set, the intercostal vessels and nerves intervening, and, beyond, the angles of the ribs with the pleura lining the chest. The internal intercostals are covered internally by the pleura, externally by the preceding set and their aponeurotic continuations in front, the abovementioned vessels and nerves intervening.

Use.—To approximate the ribs, by which action, the sternum and first rib being fixed, the chest is dilated.

Having completed the dissection of the muscles on one side, the student should turn to the opposite for the purpose of studying the axilla or armpit.

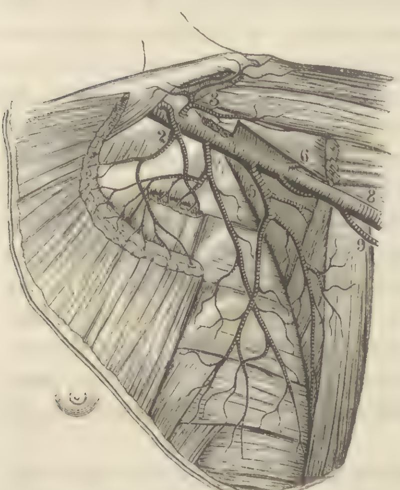
THE AXILLARY REGION.

Dissection.—Turn the subject upon the opposite side, fix the arm out at a right angle with the body, and from its anterior upper part make two incisions, one running along the prominent posterior margin of the axilla downward and backward, and the other along the anterior border downward and forward. The triangular flap of skin thus marked off should next be dissected down, and the loose areolar and adipose tissue, lymphatic glands, and small veins (which are very numerous) carefully removed. Great caution and an abundant stock of patience are required for the proper performance of this dissection, and, as it is a region in which surgical operations are not unfrequently necessary, the student should examine it with care.

The *axillary lymphatic glands*, necessarily removed along with the areolar and adipose tissues, are numerous, and some of them are often quite large. They receive the lymphatic vessels of the upper extremity, and are frequently the seat of inflammatory action, both acute and chronic.

The Axilla is a triangular, pyramidal space, bounded in front by the two pectoral muscles, posteriorly by the latissimus and greater teres muscles on their way to the upper part of the humerus, and internally by the side of the thorax, covered by the great serrate muscle. The apex of the cavity corresponds to the shoulder joint, and the base is the large triangular opening formed by the lower margins of the lateral walls. Its contents are, the axillary artery and vein with their several branches, the axillary or brachial nerves, numerous lymphatic glands, and a large quantity of loose areolar and adipose tissues.

Fig. 217.



View of axillary artery, portions of pectoral and deltoid muscles removed. 1, axillary artery; 2, superior thoracic; 3, acromial thoracic; 4, long thoracic; 5, subscapular; 6, anterior circumflex; 7, posterior circumflex; 8, brachial artery; 9, superior profound artery.

The **Axillary Artery** is the continuation of the subclavian, and extends from over the first rib to the outer border of the posterior boundary of the axilla, where it becomes the brachial or humeral artery. Its direction depends upon the position of the arm, being curved upward and outward when the limb is elevated, horizontal when extended at right angles, and curved downward when the arm is hanging by the side.

Relations.—As the artery enters the axilla, it is situated below the clavicle and subclavian muscle, external to the subclavian vein, and internal to the great plexus of nerves; and is crossed by the cephalic vein, as this vessel curves downward through the triangular space between the deltoid and great pectoral muscles to open into the axillary vein. About the middle of the cavity, however, the large vein is placed nearly in front, while the axillary plexus disposes itself around the artery so as almost to conceal it from view.

Branches.—The branches of the axillary artery are subject to great variation, but, as a general rule, the number of the principal ones is five. They are, the acromio-thoracic, long thoracic, subscapular, anterior and posterior circumflex.

The *Acromio-thoracic Artery* arises from the anterior aspect of the axillary, immediately beyond the first rib, ascends over the superior or inner border of the small pectoral muscle, and divides into the acromial and superior thoracic. The *acromial* passes outward over the anterior surface of the small pectoral muscle, and is distributed to the deltoid muscle and other structures about the top of the shoulder. The *superior thoracic* descends between the two pectoral muscles, to which it is distributed.

The *Long* or *Inferior Thoracic Artery* comes off near the middle of the axillary artery, descends along the inferior or outer border of the small pectoral muscle and upon the posterior surface of the great pectoral, to both of which, to the mammæ, and to the side of the thorax, it is severally distributed.

The *Subscapular Artery*, the largest of the branches of the axillary, arises from the lower aspect of this vessel, opposite the anterior border of the scapula, beneath which it descends in company with the subscapular nerve, and divides into a thoracic and scapular branch. The *thoracic* division passes downward and outward, and is distributed to the great serrate and some of the muscles of the back; the *scapular* portion sends off a large branch (dorsal branch) which turns over to the muscles on the back of the scapula, while the main trunk continues on toward the lower angle of the bone, where it anastomoses with the long thoracic and posterior scapular—a branch of the subclavian. In its course it sends branches to the small and large teres muscles, and particularly to the subscapular muscle.

The *Anterior Circumflex Artery* arises just below the preceding, winds around the anterior aspect of the neck of the humerus, lying under the origins of the coraco-brachial and biceps muscles, and is distributed to the muscles and ligaments about the shoulder joint.

The *Posterior Circumflex Artery*, a vessel of considerable size, arises nearly opposite the subscapular, passes backward and then outward, close under the neck of the humerus, accompanied by the circumflex nerve, and is distributed to all the adjacent structures, particularly to the deltoid muscle.

The **Axillary Vein** has the same general direction as the artery, in front of and upon the inner side of which it is situated, resting below upon a strong aponeurotic membrane, called, from its attachment, the *costo-coracoid.* The veins that open into it are numerous; thus, it receives below, and, in fact, is the continuation of, the two accompanying veins of the brachial artery; a little higher up it receives the basilic; near its upper extremity, the cephalic; and, at different parts of its course, the several veins that accompany the branches of the axillary artery.

The **Axillary Plexus of Nerves** is the continuation of the brachial plexus, and is at first entirely on the outer side of the artery; but about the middle of the cavity it divides into six main trunks, which are placed as follows: Two large roots, one from the inner and the other from the posterior side of the artery, unite across this vessel to form the *median nerve,* which is at first placed somewhat upon its outer side, but as it descends gradually gains its front, and in the lower part of the arm, as will be hereafter seen, is situated upon its inner side. Behind the artery, the *musculo-spiral* or *radial nerve,* nearly if not quite as large as the median, descends toward the back of the arm, and the *circumflex* curves beneath the neck of the humerus. Upon the inner side lie the *ulnar* and the *internal cutaneous nerves,* the latter the smallest of the group, both of which descend along the inner part of the arm. Upon the outer side the *external cutaneous nerve* passes off toward the external border of the arm.

Fig. 218.

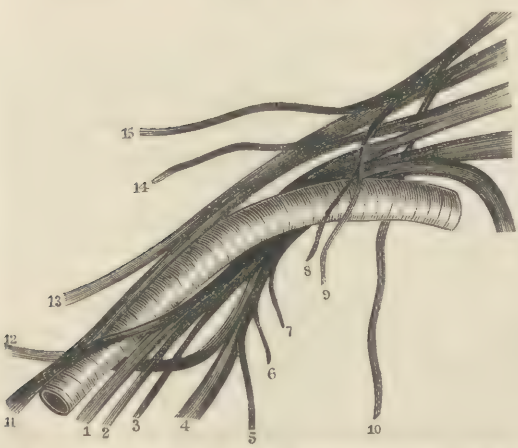


Diagram of brachial plexus of nerves, and their relation to axillary artery. 1, ulnar nerve; 2, internal cutaneous; 3, lesser cutaneous; 4, musculo-spiral or radial; 5, nerve to latissimus muscle; 6, nerve to greater teres; 7, nerve to subscapular; 8, 9, anterior thoracic nerve to pectoral muscles; 10, nerve to great serrate muscle; 11, median; 12, circumflex; 13, external cutaneous; 14, suprascapular; 15, posterior scapular.

Besides the six main divisions above mentioned, the axillary plexus gives off branches to the side of the thorax and under part of the scapula. The thoracic branches, called the *anterior thoracic nerves,* two in number, supply the two pectoral muscles. The *subscapular nerves,* three in number, de-

scend beneath the inner border of the scapula, are distributed respectively to the subscapular, small teres, and latissimus muscles.

Axillary Intercostal Nerves.—In the dissection of the axilla numerous muscular and cutaneous branches of the intercostal nerves are encountered, the most interesting one of which, called the *intercosto-humeral*, is a branch of the second dorsal nerve; it perforates the great serrate muscle, crosses the axillary space, and ramifies beneath the skin of the upper back part of the arm, anastomosing here with the internal cutaneous, a branch of the axillary plexus.

INTERIOR OF THE THORAX.

Dissection.—Divide the costal cartilages on each side, where they join their respective ribs, taking care not to carry the scalpel so deep as to cut the lungs or heart, and disarticulate the sternal extremities of the clavicles. Next raise the lower extremity of the sternum and dissect off the sternal attachment of the diaphragm, and the bone will be held only by the membranous septum, called the anterior mediastinum, which is attached to the whole length of its under surface, separating the two sides of the cavity of the chest, and must also be divided.

The sternum having been removed, the serous membrane should be dissected from its under surface, so as to expose the triangular muscle and internal mammary vessels.

The **Triangular Sternal Muscle** (*triangularis sterni*), very thin and triangular, arises upon each side, from the under surface of the ensiform cartilage and adjacent portion of the sternum, ascends outward, and is inserted into the third, fourth, fifth, and sixth costal cartilages, by as many thin tendinous and fleshy slips.

Relations.—It is covered underneath by the pleura, which separates it from the fibrous sac of the heart, and is in contact by its opposite surface with the ensiform cartilage, sternum, costal cartilages, and internal mammary vessels.

Use.—To depress the cartilaginous extremities of the ribs, and thus assist in expiration.

The **Internal Mammary Artery** is a branch of the first portion of the subclavian. From its origin it descends at first a little forward behind the inner extremity of the clavicle, to reach the posterior surface of the cartilage of the first rib, and then almost vertically behind the costal cartilages, about a quarter of an inch from the border of the sternum, as far as the sixth rib, where it divides into two branches. In its course, it lies between two accompanying veins, and is covered posteriorly by the pleura and crossed by the triangular muscle. Of its two terminal branches, one runs outward along the border of the thorax, and the other out upon the anterior abdominal wall, anastomosing with the epigastric.

Branches.—The internal mammary gives off in its course: 1, a long slender branch which accompanies the phrenic nerve to the diaphragm;

2, small twigs to the areolar tissue in the anterior mediastinum; 3, *perforating arteries* which perforate the intercostal muscles, and are distributed to the great pectoral muscle and mammary gland, the branches to the latter being quite large in the female; 4, *anterior intercostals* to the intercostal spaces, from the first to the seventh inclusive, supplying the anterior extremities of the intercostal muscles, and anastomosing with the intercostal branches of the aorta.

The two *Internal Mammary Veins* accompany the artery, unite above in a common trunk, and terminate, the left in the left innominate vein, and the right in the superior cava.

Position of the Thoracic Viscera.—Turning now to the interior of the thorax, it will be observed that the middle of the cavity is occupied in a great measure by the heart, contained within the pericardium, and by the great vessels that communicate with this organ. Upon each side are the lungs, which, if perfectly healthy, and unattached by morbid adhesions to the surrounding parts, will be found in a collapsed condition; before the chest is opened, however, they not only entirely fill the lateral spaces, but extend also nearly to the median line in front, overlapping the heart, so as to leave only about one or two square inches of its anterior surface uncovered. The collapsed state, in which they are ordinarily seen, is owing to the admission of air into the chest, as may be proved by putting a ligature upon the trachea previous to dividing the costal cartilages; or, better, by opening the cavity under water.

THE PLEURÆ.

The Pleura is a large serous sac interposed between the exterior of each lung and the surrounding structures, the office of which is to furnish a smooth surface for the parts to move freely upon one another in respiration. As there are two lungs, there are, of course, two pleuræ; which, like all other structures of the same class, are shut sacs, and consist each of a visceral and parietal portion, the former covering the contained organs, and the latter lining the parietes or walls of the cavity. The parietal portion lines the ribs, costal cartilages, and intercostal muscles, constituting what is denominated the *costal pleura*, and also the upper surface of the diaphragm, where it is known as the *diaphragmatic pleura.* From the ribs posteriorly the membrane passes over the sides of the dorsal vertebræ, and thence directly forward to the root of the lung, forming, where it stretches between these last two points, one layer of the posterior mediastinum, the pleura of the opposite side forming the other layer in the same manner. Continued from the root of the lung behind, the membrane invests the whole of the free surface of the lung around to the front of the root, constituting what is called the *pulmonic pleura;* thence

it is continued upon the exterior of the pericardium to its anterior aspect, where, meeting with its fellow of the opposite side, it stretches forward to the under surface of the sternum and costal cartilages, to form the anterior mediastinum.

The connection between the pleura and the parts which it invests is a close areolar tissue, that, upon the interior of the walls of the chest, is so condensed as to constitute a proper fibrous membrane, which, being involved in inflammation of the serous membrane, is said to explain the acute pain attendant upon this disease.

The lungs are separated from each other, in front, by the reflection of the two pleuræ from the under surface of the sternum to the anterior surface of the pericardium, the two membranes forming here a kind of septum, called the *anterior mediastinum.* In the middle, the lungs are divided by the heart and great vessels, which have hence been said to occupy the *middle mediastinum;* and behind, by the reflection of the serous membranes from the sides of the vertebræ to the roots of the lungs, inclosing the œsophagus, thoracic aorta, pneumogastric nerves, and several other structures, and denominated the *posterior mediastinum.* The space above the heart which is occupied by the great vessels, and communicates with the anterior and posterior mediastina, is generally called the *superior mediastinum.*

Fig. 219.

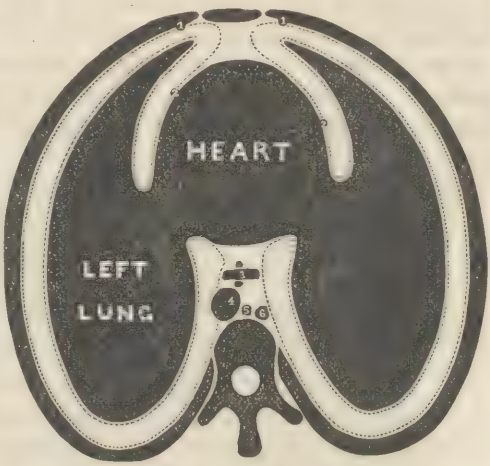


Diagram of reflections of pleural sacs in dotted lines 1, 1, internal mammary arteries; 2, 2, phrenic nerves; 3, œsophagus with pneumogastric nerves; 4, aorta; 5, thoracic duct; 6, azygos vein.

ANTERIOR MEDIASTINUM.

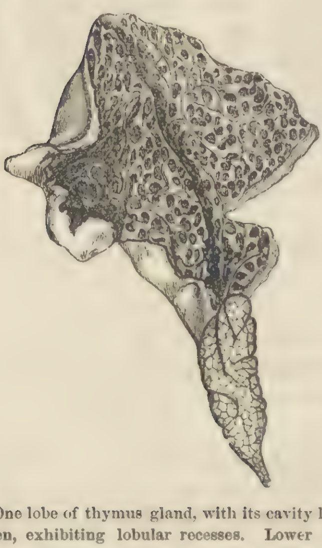
The Anterior Mediastinum is not placed precisely in the median line, but inclines below to the left side. In the greater part of its extent it is very narrow, the two pleuræ being nearly in apposition; but superiorly the two laminæ separate from each other, and inclose a narrow triangular space, occupied by the origins of the sterno-hyoid and sterno-thyroid muscles, and in the fœtus by the thymus gland, which is usually converted in the adult into areolar adipose tissue, of a dark-brown color.

The **Thymus Gland*** or **Body** is peculiar to fœtal life and early infancy. It consists of two flattened triangular lobes united together in the median line by areolar tissue, and occupies the upper part of the anterior mediastinum and root of the neck in front of the trachea, extending upward as high as the thyroid body. Its posterior surface rests upon the pericardium, left innominate vein, arch of the aorta, innominate artery, left carotid, and pneumogastric nerve, and is separated from the trachea by the inferior and middle thyroid veins. It is covered in front by the first bone of the sternum and the sterno-hyoid and sterno-thyroid muscles.

This organ is developed but slowly until the seventh or eighth month of fœtal life, when it undergoes a rapid augmentation, and continues to increase in size until the second or third year after birth, when it begins to diminish, and generally disappears about the twentieth or thirtieth year. At birth it weighs about half an ounce. It is of a pale pinkish-white color, presents an indistinct lobular outline, and is divided by a well-marked constriction into a thoracic and cervical portion, of which the former is much the larger.

Each lobe contains an irregular cavity lined by a vascular membrane, and filled with a whitish fluid resembling chyle. The exterior of the organ is covered by a thin fibrous capsule, which is prolonged internally so as to form numerous minute lobules surrounded by a vascular network, and lined by a continuation of the lining membrane of the central cavity with which all of them communicate. The central cavities of the two lobes do not communicate with each other, nor have they any outlets, unless through the lymphatic vessels, as supposed by Sir A. Cooper. Its function is entirely unknown.

Fig. 220.



One lobe of thymus gland, with its cavity laid open, exhibiting lobular recesses. Lower extremity of figure exhibits outlines of lobules.

The *arteries* of the thymus gland are derived from the internal mammary and inferior thyroid. Its *veins* open into the left innominate and inferior thyroid. The *lymphatics* terminate in the adjacent lymphatic glands. The *nerves* are branches of the pneumogastric and sympathetic.

* The thymus gland of the calf is known as the *sweetbread*.

SUPERIOR MEDIASTINUM.

The Posterior Mediastinum cannot be examined until after the removal of the lungs and heart; before doing which, the student should dissect the angular space (Superior Mediastinum) situated between the summits of the lungs, in order to study the great vessels which here enter and emerge from the base of the heart.

Dissection.—Turn aside the two divergent layers of the anterior mediastinum above, and carefully remove the areolar tissue which fills up the intervals of the bloodvessels. In doing this it will be observed that the vessels, especially the veins, are surrounded by a prolongation of the cervical fascia, which is attached to the upper border of the sternum and first rib on each side, and seems to be intended, in part, to keep the great veins constantly open. By a previous examination of Fig. 221, the student will see the relative position of the structures to be exposed.

The **Left Brachio-cephalic or Innominate Vein** is the first vessel encountered in performing this dissection. It is formed by the union of the left jugular and subclavian veins, which takes place just behind the left sterno-clavicular articulation. From its commencement it passes somewhat obliquely across to the right side, where it joins its fellow to form the superior cava. In its course it lies immediately behind the upper margin of the sternum (rising somewhat above this bone, when the head is thrown far back), in front of the innominate and left carotid arteries and the trachea, and just above the highest point of the arch of the aorta. Immediately at the junction of the jugular and subclavian veins, by which it is formed, it receives behind the termination of the thoracic duct, which may be seen by dividing the jugular and turning it down.

The **Right Brachio-cephalic** or **Innominate Vein**, formed by the confluence of the right jugular and subclavian veins, is not more than a fourth as long as the left; it passes downward and to the right, lying in front of and a little way externally to the innominate artery, and unites with the left innominate vein behind and a little below the cartilage of the first rib of the right side.

The **Superior** or **Descending Cava**, formed by the union of the two innominate veins, returns the venous blood from the superior extremities, head, neck, and back of the thorax, to the right side of the heart. It is not more than two or three inches long, but very large, descends almost vertically from its commencement, enters the pericardium and opens into the right auricle of the heart. Before entering the pericardium, it is covered upon its right side by the pleura, and is in contact with the border of the corresponding lung, which is slightly grooved for its reception. Internally, it is in relation with the ascending portion of the aorta, and

behind with the trachea, from which, however, it is separated by some of the bronchial lymphatic glands, recognized by their black color. It is also in contact with the right diaphragmatic nerve, which passes around its external surface to reach the side of the pericardium. It receives posteriorly the great azygos vein, which collects the blood from the walls of the thorax, curves over the root of the right lung, and opens into the cava just before this vessel becomes covered by the pericardium.

The Thoracic Aorta.—To the left of the superior cava vein, the Aorta, the main stem of the whole arterial system, ascends through the pericardium, and makes a curve of at least two-thirds of a circle, denominated the *arch of the aorta.* Before it can be properly studied, the pericardium should be slit open for the length of two or three inches in order to expose the portion contained within this sac. It will then be seen that, after leaving the base of the heart, it at first ascends forward and a little to the right side for the distance of about two inches; it next curves backward and toward the left over the root of the left lung, the highest point of the curve being about an inch below the level of the top of the sternum; it then descends obliquely as far as the left side of the body of the third dorsal vertebra, where it becomes vertical and continues down through the posterior mediastinum, lying in front of the spine a little to the left of the median line.

Relations.—The first or ascending division of the arch of the aorta is contained within the pericardium, and covered by the serous lining of this sac; it is partly concealed from view by the right auricular appendage and the root of the pulmonary artery, and is in immediate contact, upon the right side, with the superior cava. The second or horizontal division is covered in front and on the left side by the pleura, and crossed by the left diaphragmatic and pneumogastric nerves, the recurrent or inferior laryngeal branch of the latter winding beneath it, and ascending across its right side; above it is in contact with the left innominate vein; behind and to the right, with the trachea and œsophagus; and below, with the right branch of the pulmonary artery. Its third or descending division lies within the posterior mediastinum, and cannot, at present, be seen.*

The *Branches of the Aorta* seen in this dissection are the three large trunks, the brachio-cephalic or innominate, left common carotid, and left

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* Peculiarities of position of the arch of the aorta and its vessels, although very various, are not frequent. The top of the arch is generally situated about an inch below the upper margin of the sternum; sometimes just upon a level with it; and in fewer instances an inch and a half below. Very rarely, the arch turns over the root of the right lung instead of the left. Peculiarities in the origin of the branches are more common, especially the one in which the left primitive carotid arises from the innominate, but none of them are of sufficient frequency for description in an elementary work.

subclavian arteries, which originate from the top of the arch, and supply the head, neck, and superior extremities.

Fig. 221.

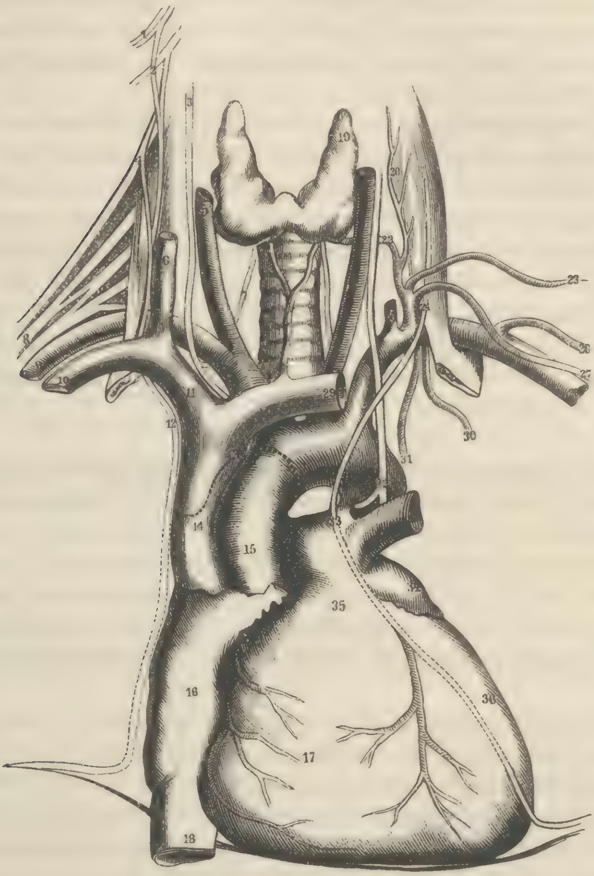


Diagram of heart and adjacent vessels and nerves; branches of right subclavian artery, corresponding to those of left, are not exhibited in this diagram. 1, third cervical nerve; 2, fourth cervical nerve; 3, pneumogastric nerve; 4, fifth cervical nerve; 5, right carotid artery; 6, right jugular vein; 7, recurrent laryngeal nerve; 8, brachial plexus of nerves; 9, right subclavian artery; 10, right subclavian vein; 11, right innominate vein; 12, 24, 33, phrenic nerve; 13, line of attachment of pericardium; 14, superior cava; 15, aorta; 16, right auricle; 17, right ventricle; 18, inferior cava; 19, thyroid body; 20, ascending cervical artery; 21, anterior scalene muscle; 22, inferior thyroid artery; 23, superficial cervical artery; 25, vertebral artery; 26, posterior scapular artery; 27, suprascapular artery; 28, left subclavian artery; 29, left innominate vein; 30, superior intercostal artery; 31, internal mammary artery; 32, pneumogastric nerve; 34, appendix of left auricle; 35, root of pulmonary artery; 36, left ventricle.

The **Brachio-cephalic** or **Innominate Artery**, the largest of the three, arises from the arch of the aorta, just at the commencement of the horizontal part of its curve, upon a plane anterior to the two succeeding

vessels, and nearly in the median line of the body. From its origin it ascends a little backward and to the right across the front of the trachea, and, having gained the right side of the latter, divides behind the right sterno-clavicular articulation into the primitive carotid and subclavian of the corresponding side. It measures, therefore, only about an inch or an inch and a quarter in length. It is in relation, in front, with the left innominate vein, which crosses it at right angles, and separates it from the origins of the sterno-hyoid and sterno-thyroid muscles upon the posterior surface of the upper part of the sternum; behind, with the trachea, which it crosses obliquely; on the right, with the pleura, which invests about one-third of its circumference, and separates it from the border of the corresponding lung; and, on the left, with the thyroid plexus of veins, and a quantity of areolar adipose tissue filling up the triangular interval in front of the trachea, formed by the divergence of this and the left primitive carotid artery. When the head is thrown far back, the innominate, where it crosses the front of the trachea, rises upon a level with the sternum, and sometimes a little above it, and is in danger of being wounded in tracheotomy.

The **Left Primitive** or **Common Carotid Artery** arises immediately to the left and a little behind the preceding, ascends at first somewhat outward, and then vertically along the left side of the trachea to the neck, where it has been already seen. Within the chest it is in relation, in front, with the commencement of the left innominate vein; externally, with the pleura and pneumogastric nerve; internally, with the trachea; and behind, with the thoracic portion of the left subclavian artery.

The **Left Subclavian Artery** arises from the arch of the aorta, just beyond and behind the left carotid, extends for the distance of nearly an inch vertically upward, then curves outwardly over the front of the apex of the left lung to reach the root of the neck. Its thoracic portion is in relation, in front, with the left carotid artery and subclavian vein; internally with the pneumogastric and diaphragmatic nerves; behind, with the spine; and externally, with the left layer of the anterior mediastinum, to which it is closely connected.

The **Diaphragmatic** or **Phrenic Nerves**, also seen in this dissection, descend vertically into the thorax, the left along the inner side of the left subclavian artery and over the arch of the aorta, and the right over the right subclavian artery, and then upon the outer side of the superior cava vein. They then become applied to the corresponding sides of the pericardium beneath the pleura, about an inch in front of the roots of the lungs, and, having in this manner reached the diaphragm, they spread out into its substance. Each nerve is accompanied in its course along the

pericardium by a very small artery, the *Superior Phrenic Artery* (a branch of the internal mammary), and by a corresponding vein.

The **Pneumogastric Nerve** of the right side may here be observed entering the chest between the subclavian vein and artery, whence it passes behind the left innominate and superior cava veins to the side of the œsophagus, with which it may be seen in the dissection of the posterior mediastinum. The left descends between the corresponding carotid and subclavian arteries, crosses the arch of the aorta, sending its recurrent branch around this vessel, and enters the posterior mediastinum.

Before proceeding to the examination of the posterior mediastinum, the parts presented after removal of the lungs and heart should be carefully studied.

Dissection for Removal of the Lungs and Heart.—The trachea and œsophagus having been already cut across a short distance below the cricoid cartilage, the carotid and subclavian arteries, jugular and subclavian veins, pneumogastric and diaphragmatic nerves should be divided in the root of the neck; next, turn first one lung and then the other to the opposite side, and divide the pleura and intercostal vessels close along the side of the spine. If the trachea and œsophagus are now taken hold of above, and drawn forcibly downward, no further use of the knife will be required except to divide the aorta and inferior cava vein where they pass through the diaphragm. If there are any pleuritic adhesions, these will of course have to be first dissected loose before anything can be done.

The lungs and heart having been thus removed, the student should examine the thoracic cavity with reference to its size and shape. and the character of its internal surface, and also dissect out the thoracic portion of the sympathetic nerve, and some of the anterior divisions of the dorsal spinal nerves that accompany the intercostal arteries. When this is done, let him wash the lungs and proceed to a careful dissection of the parts contained in the posterior mediastinum.

THE CAVITY OF THE THORAX.

The Cavity of the Thorax differs very greatly in size in different individuals, but as an ordinary rule bears a close relation to the general development of the muscular system; it is therefore smaller in the female than in the male, and in persons who lead an inactive life than in those accustomed to much bodily exercise. It is conoidal in shape, flattened from before backward, and encroached upon in the middle line behind by the bodies of the dorsal vertebræ. Its greatest horizontal diameter is the transverse, and its shortest the antero-posterior; but, measured a little to one side of the median line, the antero-posterior diameter is often nearly as great as the transverse, owing to the backward curvature of the ribs upon each side of the spine. Its *base* is not represented by the plane of the lower margin of the cavity in its skeleton state, but corresponds to the superior surface of the diaphragm, the convexity of which upon the right side reaches to a level with the lower border of the fourth intercostal space, and upon the left to that of the fifth. Its *apex* is not truncated,

as might be inferred from an examination of the skeleton, but is prolonged on each side behind the scalene muscles about two inches above the first rib, the space between being occupied by the trachea, œsophagus, and great vessels destined for the head, neck, and superior extremities. Its *inner surface* is rendered smooth by the parietal or costal layer of the pleura, which is reflected forward from the sides of the bodies of the dorsal vertebræ, and backward from the under surface of the sternum, to constitute the posterior and anterior mediastina. Beneath, or rather exterior to this lining serous membrane, are the inner surfaces of the ribs, costal cartilages, sternum, and internal intercostal muscles, forming the walls of the cavity, to which it is adherent by a layer of condensed areolar tissue, called the *subpleural aponeurosis.*

Dissect the parietal pleura from either side of the spine, and the sympathetic nerve will be brought into view.

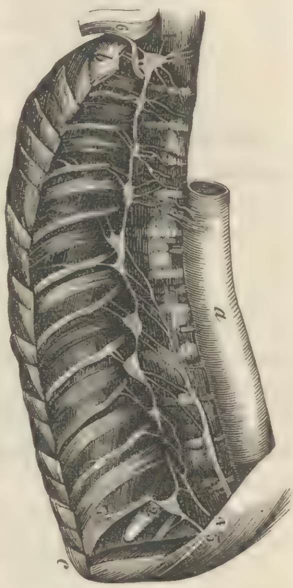
The **Thoracic Sympathetic Nerve** (Fig. 222) is continuous with the cervical and abdominal portions already described, and lies along the line of the heads of the ribs, opposite each of which it presents a small enlargement or ganglion. From these twelve ganglia, filaments are sent to the intercostal spinal nerves, to the several thoracic viscera, and to some of the plexuses of the abdomen. The last-named branches are the three splanchnic nerves, distinguished from each other as the great, small, and smallest. The *Great Splanchnic Nerve* (Fig. 222, $_3$) is a cord of considerable size formed by the union of filaments from the seventh, eighth, ninth, and tenth thoracic ganglia; it descends inward, and perforates the corresponding pillar of the diaphragm to enter the abdomen, and terminates in the semilunar ganglion. Although apparently an offset from the sympathetic, it is in a great measure composed of spinal fibres, which the ganglia receive from the dorsal nerves. The *Small Splanchnic Nerve*[4] is derived from the tenth and eleventh ganglia, descends through the diaphragm near the spine, and terminates in the cœliac plexus. The *Smallest* or *Third Splanchnic Nerve*,[5] a mere twig, comes from the twelfth ganglion, perforates the diaphragm near by, and joins the renal plexus.

Dissect the costal pleura and the internal intercostal muscles from one side of the chest, and the intercostal nerves, arteries, and veins will be exposed.

The **Intercostal Nerves** (Fig. 222) are the anterior divisions of the dorsal spinal nerves, and correspond in number to the ribs. The *first* of the twelve joins the brachial plexus, and sends off a small branch that runs along the first intercostal space, and is distributed principally to the corresponding internal and external intercostal muscle, between which it is placed. The *second* follows the corresponding intercostal space be-

tween the two muscles, and is remarkable for its large cutaneous branch, called the *intercosto-humeral*, which crosses the axilla to be distributed to the skin of the upper back part of the arm. The nine succeeding intercostals accompany the arteries of the same name; the fourth, fifth, sixth, and seventh reach as far forward as the sternum, near which they divide up into cutaneous branches (anterior cutaneous nerves of the thorax); the eighth, ninth, tenth, and eleventh are continued forward across the lower margin of the thorax and between the internal oblique and transverse abdominal muscles, to the straight muscle and the integument near the median line of the abdomen. The *twelfth* intercostal nerve is situated below the twelfth rib, crosses the front of the square lumbar muscle obliquely from within outward and downward, perforates the lumbar origin of the transverse muscle, and then, running a short distance between this and the internal oblique muscle, pierces the latter and the external oblique above the iliac crest to reach the skin over the outer and upper part of the hip. The intercostal nerves communicate with the thoracic ganglia of the sympathetic by an interchange of filaments as represented in the accompanying figure.

Fig 222.



Representation of ganglia of sympathetic in chest (the ganglia are represented disproportionately large). *a*, aorta; *b*, first rib; *c*, eleventh rib. 1, first thoracic ganglion; 2, last thoracic ganglion; 3, great splanchnic nerve; 4, small splanchnic nerve; 5, smallest splanchnic nerve; 6, part of brachial plexus; 7, intercostal nerve.

The **Intercostal Arteries,** ten in number on each side, are all branches of the aorta except the first two, which come from the subclavian. From their origin, they curve around the bodies of the dorsal vertebræ to reach the middle of the intercostal spaces, and then ascend obliquely, lying between the internal and external intercostal muscles to reach the groove upon the inner aspect of the lower margin of the rib above. In this position they curve forward, becoming smaller and smaller by successive branching, to anastomose with the superior seven or eight intercostal branches of the internal mammary, and the inferior three or four with the epigastric upon the anterior wall of the abdomen.

Just at the point where each artery reaches its intercostal space, it gives off a *dorsal branch*, which passes immediately backward to the deep muscles of the back, and, a little farther on, a long delicate branch that runs along the superior border of the rib below.

Each artery is accompanied by an *Intercostal Vein*, which opens into the azygos vein, and by one of the intercostal nerves above mentioned.

The student may now turn his attention to the lungs and heart; and first of all to the posterior mediastinum, the lateral layers of which should be dissected back, and the contained structures freed from areolar tissue.

POSTERIOR MEDIASTINUM.

The Posterior Mediastinum is formed by the reflection of the two pleuræ from the sides of the bodies of the dorsal vertebræ to the roots of the lungs. The space included between these two layers is bounded in front by the heart, covered by its pericardium, and behind by the front of the spine, and is occupied by the descending aorta, azygos vein, œsophagus, pneumogastric nerves, thoracic duct, and lower part of the trachea.

The **Thoracic Aorta**, after forming its arch, enters the posterior mediastinum upon the left side of the body of the third dorsal vertebra, and descends in front of the spine, a little to the left of the middle line, to the aortic opening of the diaphragm, through which it enters the abdomen.

Relations.—It is situated at first to the left of the œsophagus; but, in the lower part of the chest, this tube crosses it very obliquely in front to reach the œsophageal opening in the diaphragm; upon its left side, it is covered by the corresponding layer of the posterior mediastinum, and is in contact with the smaller azygos vein; internally, it is in relation above with the œsophagus; anteriorly, with the heart; and behind, with the thoracic duct and spine.

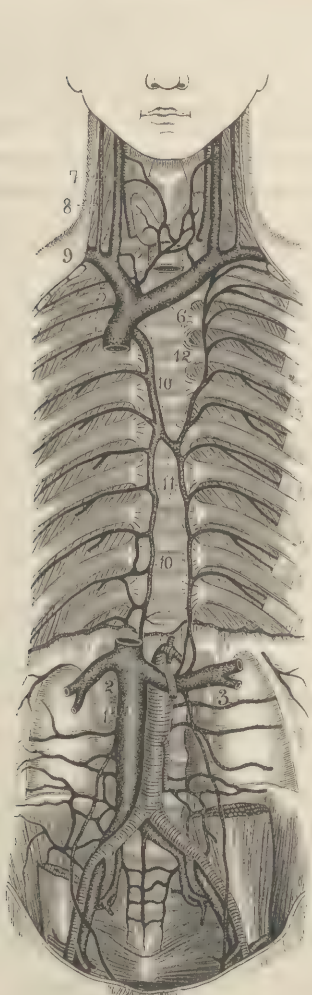
Branches.—The descending thoracic aorta gives off the intercostal, bronchial, and œsophageal arteries.

The **Intercostal Arteries** are given off from the posterior part of the aorta in pairs, of which there are nine or ten—the two superior intercostal spaces being supplied from the subclavian. From their origin, they wind around the bodies of the vertebræ, as previously mentioned, to reach the middle of the intercostal spaces, give off a dorsal branch to the muscles of the back, and, continuing along the lower borders of the ribs between the intercostal muscles, supply the muscular walls of the thorax.

The **Bronchial Arteries**, the proper nutritious arteries of the lungs, are subject to great variety in size, number, and origin. As a general rule, they are not larger than a small crowquill, and are three in number, two belonging to the left, and one to the right lung. The one for the right lung originates usually from the anterior face of the commencement of the descending aorta, and the two for the left come from the first aortic intercostal artery; but not unfrequently all three arise by a common trunk from the front of the aorta immediately below the arch. They enter the lungs upon the bronchial tubes, which they follow to their remote terminations.

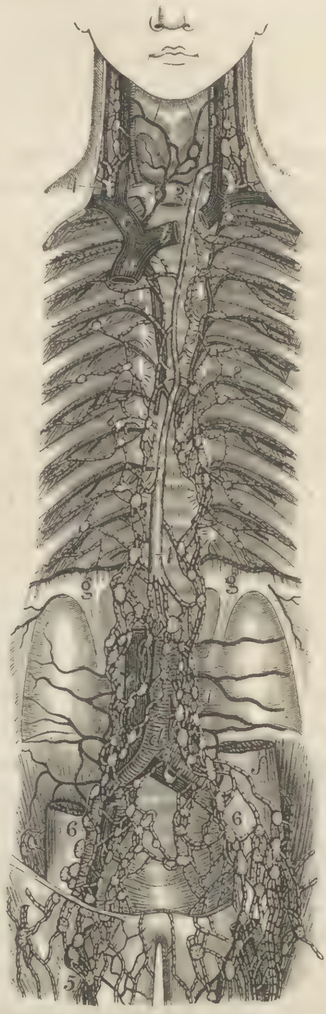
The **Oesophageal Arteries**, four or five in number, and very small, come off from the anterior part of the aorta, in the course of the œsophagus, to which they are distributed.

Fig. 223.



Veins of thorax and abdomen. 1, inferior cava; 2, right, 3, left renal veins; 4, superior cava; 5, right, 6, left innominate veins; 7, internal veins; 8, external jugular veins; 9, subclavian vein; 10, azygos vein; 11, inferior, 12, superior hemi-azygos veins.

Fig. 224.



View of great lymphatic trunks. 1, 2, thoracic duct; 3, its termination at angle of conjunction of left internal jugular and subclavian veins; 4, right lymphatic duct; 5, lymphatics of thigh; 6, iliac lymphatics; 7, lumbar lymphatics; 8, intercostal lymphatics. *a*, superior cava; *b*, left innominate vein; *c*, right innominate vein; *d*, aorta; *e*, inferior cava; *f*, psoas muscle; *g*, origin of diaphragm.

The **Azygos Vein** (Fig. 223) commences in the abdomen upon the right side of the bodies of the lumbar vertebræ, communicating here by a

small branch with one of the lumbar veins, or directly with the inferior cava. From the abdomen, it enters the thorax through the aortic opening in company with the thoracic duct, ascends along the dorsal vertebræ in front of the right intercostal arteries, passes behind the root of the right lung, and, curving forward, opens into the superior cava. In its course it receives the right intercostal, right bronchial, and the œsophageal veins; and, opposite the sixth vertebra, the main trunk, called the *smaller* or *hemi-azygos*, that collects the blood from the left intercostal veins, as represented in the accompanying plate (Fig. 223).

The **Thoracic Duct** (Fig. 224), the main trunk of the lymphatic system, is also contained in the posterior mediastinum, but owing to its small size, and more particularly to the thinness of its coats, it cannot be easily found unless previously injected. It commences in the abdomen by an elongated dilatation, called the *Receptacle of the Chyle*, resting upon the front of the lumbar vertebræ beneath the right border of the aorta, where it receives the lacteals and lymphatics of the abdominal organs; it ascends through the aortic opening in the diaphragm, and maintains the same relation to the thoracic aorta as high as the fifth or sixth dorsal vertebra; here the duct passes behind the aorta, then along the left border of the œsophagus, and, having reached the left side of the body of the seventh cervical vertebra, curves forward and downward to open into the posterior part of the left jugular vein, just where it unites with the subclavian to form the left innominate vein. When injected, the thoracic duct presents a knotted, tortuous, or serpentine appearance, and gradually diminishes in size, from below upward, to within a short distance of its termination, where it again slightly dilates. The duct is sometimes double, one division taking the ordinary course, and the other crossing over to open into the right jugular vein.

The **Oesophagus** or **Gullet**, the communicating tube between the pharynx and stomach, descends the neck between the trachea and spine, and a little to the left of the middle line. Entering the posterior mediastinum in the same relative position, it is at first upon the right side of the aorta, but, as it descends, inclines gradually across the front of this vessel to reach the œsophageal opening in the diaphragm.

The **Pneumogastric Nerves** reach the posterior mediastinum, as already described, and, having arrived behind the roots of the lungs, give off numerous branches, which here unite with branches from the sympathetic to form a large intricate network, denominated the *posterior pulmonary plexus*. Beyond this point the main trunk of each nerve divides into a large number of branches, which anastomose freely with one another upon the exterior of the œsophagus, and are continued in this connection to the stomach.

The **Lymphatic Glands** of the posterior mediastinum are situated, for the most part, close to the bronchial tubes, and are hence distinguished as the *Bronchial Glands.* They are remarkable for their black color, firm consistence, and great liability to calcareous and other morbid deposits.

The **Roots of the Lungs** may now be exposed behind by dissecting off the contents of the posterior mediastinum, care being taken not to cut the lungs themselves. Each root is a broad pedicle, by which the lung is held in its position, and will be found to consist principally of a bronchial tube, a branch of the pulmonary artery, and two pulmonary veins. To these may be added the small bronchial arteries and their accompanying veins, branches of the pulmonary plexus of nerves, and lymphatics. The arrangement of the large vessels in the antero-posterior direction is the same in the two roots, the bronchial tube being behind, the pulmonary artery in the middle, and the pulmonary veins in front: but from above downward the order is different; thus, in the *right* root the bronchial tube is highest, the pulmonary artery next, and the veins below, and in the *left*, the pulmonary artery is above, the bronchial tube next, and the veins below.

The student should now proceed to cleanse the exterior of the trachea, by dissecting off the areolar tissue by which it is surrounded.

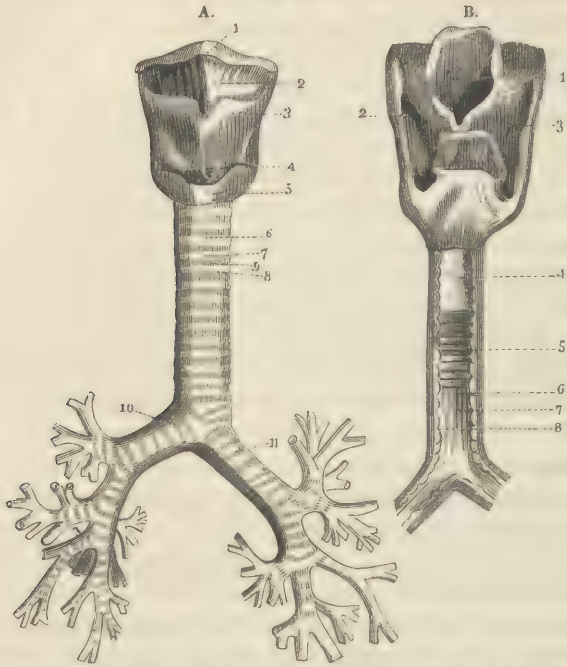
THE TRACHEA AND BRONCHIA.

The Trachea.—The Trachea or Windpipe (Fig. 225) is the firm, elastic, flexible tube, extending from the larynx along the middle line of the lower third of the neck and upper part of the thorax, to the roots of the lungs, where it divides into the two bronchial tubes. It is nearly cylindrical in form, reaches from opposite the fifth cervical to the fourth dorsal vertebra, and measures, usually, in the male adult, from four to five inches in length, and eight or ten lines in diameter. Its size differs, however, very materially in different individuals, and is less in the female than in the male. It is also liable to temporary variations in length, depending upon the elevation and depression of the larynx and the flexion and extension of the neck; and in diameter from its own contraction.

Relations.—The cervical portion of the trachea is covered, in front, by the isthmus of the thyroid body above, the thyroid plexus of veins, and the sterno-hyoid and sterno-thyroid muscles; behind, it rests upon the front of the œsophagus, which separates it from the spine, and projects a little beyond its left border; laterally, it is in apposition above with the lobes of the thyroid body, and below with the primitive carotid and inferior thyroid arteries and recurrent laryngeal nerves. Within the thorax it is crossed in front by the innominate artery, and the right branch of the pulmonary artery, and at some little distance by the left innominate

vein; and is in contact, upon the left side, with the arch of the aorta and the left primitive carotid artery; on the right, with the innominate artery, and, behind, with the œsophagus.

Fig. 225.



A. Larynx, trachea, and bronchial tubes, viewed in front. 1, hyoid bone; 2, thyro-hyoid membrane; 3, thyroid cartilage; 4, crico-thyroid membrane; 5, cricoid cartilage; 6, trachea; 7, 8, two cartilaginous rings; 9, membrane which separates them; 10, right bronchus and its divisions; 11, left bronchus.

B. Larynx, trachea, and commencement of bronchial tubes, viewed from behind. 1, upper opening of larynx; 2, 3, lateral grooves of larynx; 4, fibrous membrane of trachea, interspersed with small glands, beneath which are seen 5, muscular fibres; beneath this last are 6, 7, small fibrous bands; 8, mucous membrane seen between them.

Structure.—The trachea consists of a number of different tissues, which should be thoroughly understood, as they are continued into the substance of the lungs, and form essential elements of these organs. They are: a fibro-elastic coat, upon which the strength of the tube principally depends; incomplete rings of cartilage, by which it is kept open; muscular fibres, by which its caliber may be narrowed; a lining mucous membrane; yellow elastic fibres; and small racemose glands.

The *fibro-elastic coat* is a complete membranous cylinder, attached above to the lower circumference of the cricoid cartilage, and continued below into the bronchial tubes. Opposite each cartilaginous ring it is divided into two delicate laminæ, one covering the external and the other the internal surface, but between the rings it is a thick consistent mem-

brane, of great strength and considerable elasticity. Along the posterior wall of the tube, where the cartilages are more deficient than in the inter-annular spaces, it is in contact by its inner surface with the muscular layer, and with the tracheal glands which abound in this situation.

The *cartilaginous rings* number from fifteen to twenty, form each about three-fourths of a circle, and are arranged parallel with each other at regular intervals of a line or more in breadth. They are flattened from within outward, closely invested by the fibro-elastic coat, and terminate behind in pointed extremities. The deficiencies in the rings are all upon a line with each other behind, and thus allow the tube to be narrowed by the contraction of the muscular fibres, which exist in this situation, as illustrated in the act of coughing. In birds the rings form complete circles, and as no diminution of the caliber of the tube can therefore take place, animals of this class do not possess the power to cough.

The *muscular layer* is situated upon the inner surface of the fibrous tunic, along the posterior membranous portion of the tube, and belongs to the unstriped or involuntary variety of muscular tissue. Its fibres extend transversely between the ends of the cartilaginous rings, are pale and indistinct in the human subject, but may be well seen in some of the larger mammalia, as in the ox.

The *mucous membrane* lines the interior of the tube, and is continuous above with the lining membrane of the larnyx, and below with that of the bronchial tubes; it is thin and delicate, of a pale pink color, connected to the subjacent structures by short areolar tissue, and presents, upon its free surface, numerous minute openings leading to the ducts of the submucous glands; its epithelium is ciliated columnar.

The *yellow elastic fibres* are longitudinal in their direction, and found principally along the posterior wall between the muscular and mucous layers, where they often form distinct rugæ upon the surface of the latter. They do not form a continuous layer, and are often so feebly developed as to be difficult of demonstration.

The *tracheal glands* exist in great numbers in the posterior wall, and vary in size from that of a large pin's-head to that of a mustard-seed. The larger ones are imbedded in the fibrous tunic, but the smaller are placed in the submucous connective tissue. They belong to the racemose variety, and open by separate ducts upon the free surface of the mucous membrane.

Vessels and Nerves.—The *arteries* of the trachea are exceedingly small, and derived principally from the inferior thyroid. Its *veins*, correspondingly diminutive, open into the thyroid plexus. Its *nerves* consist of filaments from the recurrent branch of the pneumogastric and the sympathetic.

The Bronchia.—The two Bronchial Tubes diverge from their origin opposite the fourth dorsal vertebra, at an obtuse angle, and enter the

lungs behind the pulmonary arteries and veins. The *right* is half an inch in diameter, an inch in length, nearly horizontal, and in relation behind with the azygos vein. The *left* is a fourth smaller than the right, nearly twice as long, more oblique in its direction, and in relation behind with the aorta and œsophagus. Both have intimate relations with the pulmonary plexus of nerves, bronchial arteries and veins, and bronchial lymphatic glands. Their structure is essentially similar to that of the trachea.

Having entered the lungs, the bronchia undergo a successive branching, without anastomosing, into smaller and smaller tubes until they become almost capillary, and then terminate in the air vesicles, of which these organs so largely consist. But, as this division and subdivision goes on, it is observed that the cartilaginous element loses its ringlike shape, and appears in the form of gradually diminishing irregular plates, which are distributed at greater and greater intervals along the tubes, and in the smaller ramifications entirely disappear. But the other constituents, namely, the fibro-elastic and muscular, are continued on to the most remote branches, in which, indeed, the muscular element is found to be proportionally increased, and to invest the whole circumference of the tubes. The mucous membrane becomes thinner and thinner; and its epithelium, before entering the air vesicles, is found to have lost its ciliated columnar form and become tessellated.

THE LUNGS.

The Lungs occupy the lateral divisions of the cavity of the thorax, to which they accurately correspond in size and form. Their volume, however, varies very greatly in different individuals, and in the same individual in inspiration and expiration; but their average capacity may be stated at three hundred cubic inches. The weight of the two lungs, including the trachea and bronchial tubes, when entirely freed from blood and other adventitious substances, does not often, according to the author's observation, exceed sixteen avoirdupois ounces (one pound); but when first taken from the body, and only the heart removed, it varies from thirty to fifty ounces. Their specific gravity is much less than that of water or of any organ in the body, owing to the large amount of air which they contain. The color of the lungs varies with age: in infancy it is a rosy red; in the adult, a pinkish gray; and, after middle life, they present a dark mottled appearance, owing to a deposit of black pigment in the subserous and interlobular areolar tissue. Their texture is remarkably spongy and porous, and when pressed between the thumb and finger gives rise to a crackling sensation or crepitation, produced by a rupture of some of the air vesicles. Their strength is very considerable, as is proved by the impossibility of rupturing them by the ordinary means of inflation. They are also remarkably elastic, in consequence of which

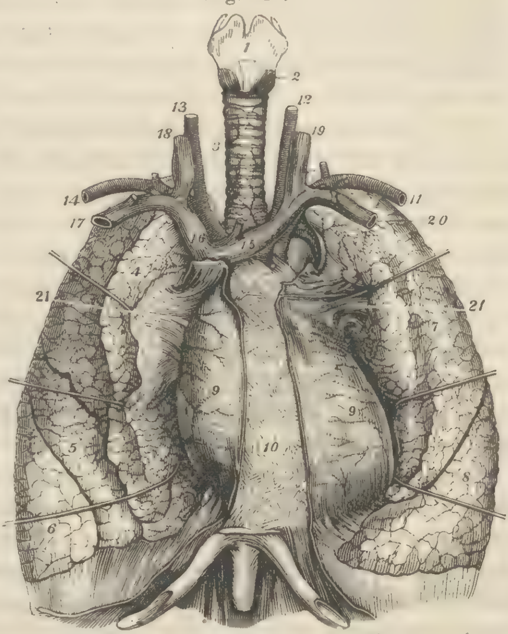
they rapidly collapse when the chest is opened, if they are perfectly healthy, and no obstacle exists to the escape of the air.

The two lungs are not of the same size: the left measures an inch more in a vertical direction, in consequence of the unequal height of the convexity of the diaphragm on the two sides; but, as it is encroached upon considerably by the heart, it is less capacious than the right. The fact is still further explained by the larger muscular development of the right side of the thorax.

Each lung is irregularly conoidal in shape, and presents for consideration an external and an internal surface, a base and an apex, an anterior, a posterior, and an inferior border.

The *external surface* is smooth and convex, and corresponds precisely to the internal surface of the lateral walls of the thorax. It is traversed obliquely from behind forward and downward by a deep fissure, whose sides are invested by an involution of the pleura, and are frequently found closely united by morbid adhesions. By this fissure each lung is divided into a *superior* and *inferior lobe;* but the right has, in addition, a short fissure running from near the middle of the preceding to the anterior border of the organ, marking off a third or *middle lobe,* which is much smaller than either of the others.*

Fig. 226.



Larynx, trachea, and lungs, with heart inclosed in pericardium, as seen in front. 1, thyroid cartilage; 2, crico-thyroid muscle; 3, trachea; 4, 5, 6, upper, middle, and lower lobes of right lung; 7, 8, upper and lower lobes of left lung; 9, 9, pericardium investing heart; 10, mediastinum; 11, left subclavian artery; 12, left primitive carotid; 13, right primitive carotid; 14, right subclavian artery; 15, left innominate vein; 16, right innominate vein; 17, right subclavian vein; 18, right internal jugular vein; 19, left internal jugular; 20, left subclavian vein; 21, 21, root of lungs.

The *inner surface* presents toward the median line, is concave, and corresponds in front to

* Not very rarely the left lung has also three lobes, and the right sometimes four, or even five.

the heart, and behind to the bodies of the dorsal vertebræ. Somewhat nearer its posterior than its anterior border, and about midway between the base and apex of the organ, it gives attachment to the vascular pedicle heretofore described as the *root* of the lung. In front of the root, the surface is much more concave on the left than on the right lung, in consequence of the position of the heart, the body and apex of this organ being imbedded in the left lung, the pericardium intervening.

The *base* of each lung is smooth and concave, corresponding to the convexity of the upper surface of the diaphragm, which, being more arched upon the right than on the left side, renders the concavity of the base of the right lung greater than that of the left.

The *apex* or summit forms a blunt, rounded point, somewhat flattened antero-posteriorly, and often marked in front by a superficial transverse groove corresponding to the first rib. Its highest point rises above the first rib to the distance of an inch and a half or two inches, the cavity of the thorax being prolonged for its reception behind the posterior scalene muscle and first part of the subclavian artery.

The *posterior border* is thick and rounded, occupies the deep groove upon either side of the spine, and, owing to the obliquity of the base of the chest, is the longest part of the organ. The *anterior border* is thin and sinuous, overlaps the anterior surface of the pericardium, and is marked by two notches, of which the superior is quite small, and corresponds on the left side to the subclavian artery, and on the right to the superior cava vein ; and the inferior corresponds on the left to the body and apex of the heart, and on the right to the base of this organ. The *inferior border* is thin, forms the circumference of the base of the heart, and corresponds to the narrow interval between the convex surface of the diaphragm and the margin of the thorax.

Structure.—The substance of the lungs, the parenchyma, as it is generally called, is probably better understood than that of any one of the other great organs of the body. It consists essentially of the ramifications of the bronchial tubes, pulmonary artery, and pulmonary veins, held together by areolar tissue, and inclosed as a whole by the investing serous membrane.

If the surface of an inflated lung be closely examined with the naked eye, it will be found marked beneath the serous covering by numerous crooked lines crossing each other in every direction, and inclosing spaces of various shapes and sizes, which are the surfaces of as many separate masses called *lobules*. If the serous membrane be now dissected off, it will be found that the lobules are held together by a delicate *interlobular areolar tissue*, which is continuous with the subserous areolar tissue, but has no communication whatever with the air vesicles. In rupture of the latter, however, the air escapes into the connective tissue, constituting what is termed "interlobular emphysema," which may extend itself

throughout the adjacent interlobular spaces and subserous areolar tissue, and thus involve a large part of the organ.

Each lobule is a lung in miniature, and will be found, upon separating it from the surrounding lobules, to possess a pedicle consisting precisely of the same structures which compose the root of the lung, viz., a bronchial tube, a branch of the pulmonary artery, a pulmonary vein, a minute bronchial artery and vein, nervous filaments, and lymphatics. The general arrangement of these structures within the lobules may be briefly explained.

Fig. 227.

Ultimate air cells of lung.

The bronchial tube, upon entering the lobule, breaks up into a great number of minute tubes, called *capillary bronchial tubes*, which consist of a fibro-elastic coat, an internal lining of mucous membrane, and an intervening layer of muscular fibres. Finally, each of these capillary bronchial tubes terminates in an irregular enlargement, called a *primary lobule*, the exterior of which presents the appearance of a bunch of closely-set grapes. The interior of the primary lobule contains a central cavity, named the *intercellular passage*, and communicating with this upon all sides are the open hemispherical *air cells*, varying a good deal in size and separated from each other by delicate septa.

The exterior of the primary lobule is composed of an expansion of the fibro-elastic coat of the bronchial tube. Its interior is lined by a squamous epithelium, resting upon a delicate basement membrane, and continuous with the mucous membrane of the bronchial tube. The muscular tissue found in the latter ceases at the entrance of the lobule. The primary lobules are closely packed together, their fibro-elastic investment serving as a bond of union, and have no direct communication with each other.

The branch of the *pulmonary artery* associated with the bronchial tube subdivides with the latter, and finally distributes itself over the air vesicles and in the intervening septa in a profusion of capillaries, constituting a network whose interstices are smaller than the vessels themselves. From this vascular net the radicles of the pulmonary veins pass off to form the main trunk, which emerges at the pedicle in company with the artery and bronchial tube.

The object of all this division and subdivision is evidently, upon the one hand, to increase to its utmost extent the free surface of the lining membrane of the lungs, and, on the other, to bring as near to this surface as practicable the greatest quantity of blood in a state of the most minute

disintegration; or, in other words, to bring the largest possible amount of blood in contact with the largest possible amount of atmospheric air. Respiration consists then simply in the constant renewal of the air in the air cells, where, by the diosmotic property common to nearly all animal tissues, an interchange of gases takes place through the delicate intervening tissue, the inspired air giving its oxygen to the impure blood, and the latter parting with its carbonic acid gas to be expelled from the body by expiration.

The *bronchial arteries* are the nutrient vessels of the lungs, and do not properly constitute a part of their peculiar tissue. They vary in number from one to two or three on each side, are not larger than a crowquill, originate from the concavity of the arch of the aorta, and follow the bronchial tubes to their remote divisions. The *bronchial veins* correspond to the arteries, and terminate, the right in the azygos vein, and the left in the superior intercostal.

The *pulmonary nerves* are branches of the pneumogastric and sympathetic nerves. Just above the root of each lung, the pneumogastric sends a small branch downward and forward to the anterior part of the root, and another to the posterior surface, which, uniting with filaments derived from the sympathetic, form the *anterior* and *posterior pulmonary plexuses*, of which the latter is much the larger. From these plexuses the pulmonary branches are derived.

The *lymphatics* of the lungs are very numerous, and consist of a superficial and a deep set; the former are situated beneath the investing pleura, and the latter ramify between and in the substance of the lobules. The two sets communicate freely, and eventually terminate in the bronchial glands situated about the roots of the organs.

THE PERICARDIUM.

The Pericardium (Fig. 226) is a fibro-serous sac inclosing the heart and the origins of the great vessels. It occupies the middle region of the thorax, and is inseparably connected with the upper surface of the central or cordiform tendon of the diaphragm. Laterally and anteriorly, it is covered by the pleura, beneath which on each side may be seen the diaphragmatic nerve descending from above downward, accompanied by a small arterial twig and a corresponding vein; in front, it gives attachment to the anterior mediastinum, and is overlapped by the anterior margins of the lungs, excepting a space somewhat more than an inch and a half square, which corresponds to the fifth and sixth costal cartilages on the left side; behind, it is separated from the spine by the contents of the posterior mediastinum. Its internal surface is smooth and free, kept constantly moist by serous exhalation, and always in contact with the contained organ. The size of the pericardium corresponds precisely to that of the heart when the cavities of the latter are distended.

Like other structures of the same class, the pericardium consists of an external fibrous and an internal serous layer. The *fibrous layer* varies in thickness and strength in different individuals, is covered externally, as above mentioned, by the pleura, lined internally by the serous pericardium, continuous above with the external coats of the large vessels, and below with the tendinous portion of the diaphragm. The *serous membrane* is exceedingly thin and delicate, closely attached to the internal surface of the fibrous layer, and prolonged over upon the roots of the large vessels and the exterior of the heart, so as to constitute a simple shut sac, bearing thus the same relation to the fibrous layer and the inclosed organ that the arachnoid does to the dura mater and brain

THE HEART.

Dissection.—Separate the heart from the lungs by dividing the pulmonary arteries and veins near where they enter these organs, and then dissect off the pericardium.

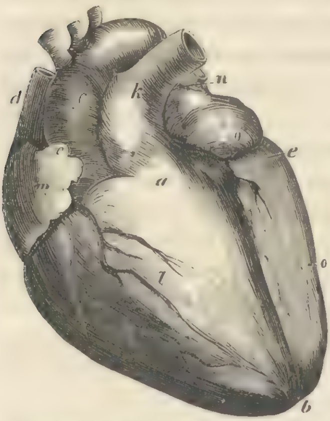
The Heart is a hollow muscular organ situated in the middle of the thoracic cavity, between the two lungs and within the pericardial sac. It is retained in its position by the connections of the vessels that communicate with its cavities; by the pericardium; and by the diaphragm, upon the upper surface of which it rests. Its size is in a great measure proportioned to that of the development of the thorax; and this being in a great degree connected with the general development of the muscular system, it was suggested by Laennec that a man's fist is generally a tolerably good measure of the size of his heart; but its absolute volume is subject to so much variety, even within the bounds of perfect health, that it cannot be correctly compared to any familiar object.

The weight of the heart, liable to as great diversity as its size, is upon an average from eight to ten ounces. In form it resembles a flattened cone, the axis of which, when the organ is in its natural position, is directed from above downward, forward, and toward the left. Its apex corresponds to a point just below the junction of the fifth rib of the left side with its cartilage: its base presents toward the right shoulder, and rests upon a level with the superior margin of the fifth rib of the right side near the spine. Its general relations are those of the pericardium; and, although inclosed between the lungs, it encroaches more upon the left than the right lung, a deep excavation existing upon the inner surface of the former for its reception.

The *External Surface of the Heart* is closely invested by the reflected or visceral layer of the serous pericardium. It is encircled somewhat nearer the base than the apex by a deep groove, interrupted in front by the root of the pulmonary artery, which gives lodgment to the coronary vein, and marks the internal separation of the cavities of the organ into

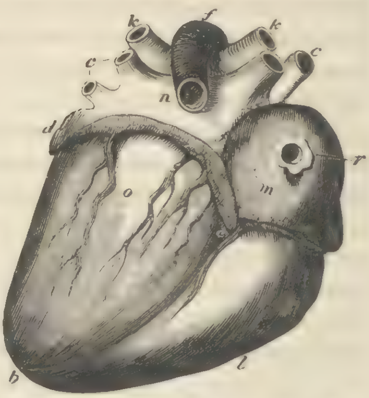
auricles and ventricles, the base being the auricular, and the body and apex the ventricular portion.

Fig. 228.



Front or upper surface of heart and great vessels injected and placed obliquely, but the apex not tilted forward as in the body. *a*, infundibulum of right ventricle; *b*, notch at apex of heart; *c*, auricular appendage of right auricle; *d*, superior cava; *f*, aorta; *e*, *b*, anterior longitudinal furrow, marking division between ventricles; *k*, pulmonary artery; *l*, right ventricle, of which chief part is seen in front; *m*, right auricle; *n*, left auricle, seen only to a small extent, with its appendage projecting forward; *o*, left ventricle.

Fig. 229.



Back or under surface of same heart. *b*, apex of heart, slightly notched; *c*, *c*, pulmonary veins, two on each side; *d*, appendage of left auricle; *e*, entrance of coronary vein into back of right auricle, *m*; *d*, *e*, part of transverse or auriculo-ventricular furrow, occupied by large coronary vein; *f*, aorta; *k*, *k*, right and left division of pulmonary artery; *l*, right ventricle, only smaller part seen; *m*, right, and *n*, left auricle, the division between them distinctly seen; *o*, left ventricle, greater part seen behind; *r*, orifice of inferior cava, constricted by ligature used to keep in injection.

The *Auricular Portion* of the heart when empty is loose and flaccid, owing to the thinness of its walls; but when distended, it projects a little beyond the circumference of the ventricular portion, and presents an irregular cuboidal form. Its *anterior surface* is marked by a deep vertical notch inclosing the pulmonary artery and aorta as these vessels leave their corresponding ventricles; the *posterior*, more irregular, is traversed by a longitudinal groove, which corresponds to the internal septum that separates the two auricular cavities; the *superior* is marked by a continuation of this same furrow; the *right* and *left lateral surfaces* are convex and bulging, and continuous, the former with the two cava, and the latter with the four pulmonary veins.

The *Ventricular Portion*, much more firm and resisting than the preceding, in consequence of the greater thickness of its walls, is conoidal, slightly flattened, and presents for examination an anterior and a posterior surface and two lateral borders. The *anterior surface* is convex, looks upward and forward toward the sternum and cartilages of the left true ribs, and is marked near its left border by a longitudinal furrow

corresponding to the septum that separates the two cavities within. The *inferior* or *posterior surface* is flattened, rests upon the central tendon of the diaphragm, and is also traversed by a longitudinal furrow situated midway between the two borders, and continuous with the one upon the anterior surface over the apex of the organ, forming here a distinct notch. Of the two *borders*, the left is thick and rounded, and corresponds to the deep excavation in the left lung; the right is comparatively thin, and rests upon the diaphragm.

The *Interior of the Heart* consists of two lateral cavities separated by a common wall or septum, and lined by an exceedingly delicate membrane, called the *endocardium*, continuous with and similar in structure to the lining membrane of the veins and arteries. They are commonly designated the right and left sides of the heart, and are subdivided each into two compartments, called the auricle and ventricle, which communicate with one another through a large opening. We have therefore a right auricle and ventricle and a left auricle and ventricle.

The **Right Auricle** forms the right anterior part of the base of the heart, is irregularly triangular pyramidal in shape, rests upon the diaphragm, and is prolonged anteriorly in front of the root of the aorta, in the form of a flattened triangular process denominated the *auricular appendage.*

Dissection.—Lay the right auricle open with the scissors, making a horizontal incision through the whole breadth of the cavity, about midway between the points of entrance of the superior and inferior cava veins. If this incision is not sufficient, it may be crossed by a vertical one just in front of the entrance of the superior cava. Next, wash out the blood and fibrinous clot that nearly always occupy the cavity. These clots, called by the older anatomists *polypi of the heart*, under the supposition that they were organic growths, are sometimes quite large, and occupy not only the auricle, but extend into the ventricle, and for a little distance into the pulmonary artery and cava veins; they have a bright yellow color, and are firm and closely adherent to the walls of the cavity. They are the result of the coagulation of the blood just before or immediately after death, and the separation of the fibrin from the red globules is probably owing to the slowness with which the coagulation takes place, thus giving the globules time to settle toward the more dependent part of the heart, which is generally the upper and back part of the auricle. Hence, the portion of the clot drawn out of the right ventricle will generally be found nearly free from red globules, and consists of almost pure fibrin.

The cavity of the right auricle (Fig. 230) is separated from that of the left auricle by a common wall or partition, called the *interauricular septum*, upon the surface of which, near its posterior margin, is a large oval-shaped depression, called the *oval fossa*, corresponding to the interauricular opening or oval foramen of the fœtal heart. Not unfrequently the opening is only partially closed for some time after birth, giving rise to the condition known as the cerulean or blue disease, and it often remains through life not quite closed, but sufficiently so to prevent

any injurious admixture of blood. The inner surface of the outer wall is smooth and even, except in the vicinity of the auricular appendage, where the muscular fibres are collected into vertical bundles, called, from some resemblance they have to the teeth of a comb, the *pectinate fibres* (musculi pectinati). In the spaces between these bundles the muscular tissue is almost entirely wanting, and the endocardium and serous pericardium being separated from one another by only a little fibrous tissue, the walls in this situation are so thin as frequently to be transparent.

The right auricle receives the venous blood from all parts of the body by three principal vessels, namely, the superior and inferior cava and coronary veins. The opening of the *superior cava*, situated upon the upper anterior part of the wall of the cavity, is as large as the caliber of the vessel itself, circular in shape, and looks almost directly downward. That of the *inferior cava*, somewhat larger than the preceding, is placed at the lower back part of the auricle, and directed obliquely upward, and toward the interauricular septum. Between these two orifices the wall of the auricle is a little thicker than elsewhere, and in some of the inferior animals forms a prominence upon the inner surface denominated the *tubercle of Lower.*

Immediately below and in front of the opening of the inferior cava is that of the *coronary vein*, by which the blood that circulates in the substance of the walls of the heart is carried into the right auricle; it is about the size of a large goosequill, and partly concealed by a delicate semicircular fold of the endocardium forming an imperfect valve (coronary or Thebesian valve), which often presents a cribriform or torn appearance. Between the mouths of the inferior cava and coronary veins, and extending from the inferior margin of the former to the inferior border of the oval fossa, is a triangular fold of the lining and muscular substance of the auricle, called the *Eustachian fold*, which is the remains of the fœtal continuation of the inferior cava. It varies in size in different individuals, being sometimes almost wanting; and again, as in a specimen in the author's possession, it is nearly as perfect as in its original state.*

By means of the three large venous orifices the venous blood from all parts of the body is poured into the right auricle, whence it is transmitted, by a slight contraction of the walls, into the right ventricle, through the large passage called the *right auriculo-ventricular opening.* This opening, situated at the junction between the two cavities, is oval in shape, nearly an inch and a half long, and about an inch in breadth,

* In the specimen referred to, obtained from a male adult, the inferior cava is to all intents and purposes continued through the cavity of the auricle up to the circumference of the oval fossa (which is entirely closed), presenting anteriorly an elliptical opening with well-defined margins. Its examination completely dispelled all doubts in the author's mind in regard to the transmission of the blood of the inferior cava of the fœtus through the oval opening into the left auricle.

and provided with a set of valves, which will be seen in the examination of the right ventricle.

The **Right Ventricle** (Fig. 230) is situated below the right auricle, and to the right and somewhat in front of the left ventricle; it is triangular pyramidal in shape, its base presenting toward the auricle, and, when distended, presents a large oblique prominence in front and above, corresponding to an internal dilatation called the infundibulum, which leads to the origin of the pulmonary artery.

Dissection.—To expose the interior of the right ventricle, reflect upward a V-shaped flap from the anterior wall of the cavity; or else make a T-shaped incision, the vertical line of which shall extend the whole length of the cavity, and the horizontal one across its base, about half an inch below its junction with the auricle.

In making this dissection, it will be observed that the walls of the ventricle are much thicker than those of the auricle, the reason for which is readily understood by reference to the larger amount of labor performed by the former. The auricle has only to send the blood to the ventricle, which is situated immediately below, and communicates by a large opening; but the ventricle has to transmit it through the pulmonary artery and its subdivisions to the lung, an act which requires considerable power, and a corresponding development of muscular tissue. This explanation applies also to the difference between the right and left ventricles; the latter, having a far more laborious function to perform than the former, has also proportionately thicker walls. It will be also noticed that the walls of both ventricles are much thinner at the apex than elsewhere, and, if it

Fig. 230.

View of heart, with anterior portions of ventricles removed. 1, interior of right ventricle, exhibiting its fleshy columns; 2, left ventricle; 3, right auricle; 4, left auricle; 5, aorta; 6, 7, 8, tricuspid valve; 9, fleshy columns, attached by tendinous cords to tricuspid valve; 10, mitral valve; 11, pulmonary artery laid open; 12, one of semilunar valves, the other two seen in section on each side of former; 13, sinus or dilatation of artery behind semilunar valve.

were not that contraction of the organ commences at this point, rupture of the heart would be a much less infrequent accident than it is.

The internal surface of the right ventricle (Fig. 230) presents a remarkable reticular appearance, due to numerous muscular fasciculi, called *fleshy columns* (columnæ carneæ), which cross each other in every direction. Of these muscular bundles, some are large and some small, some project into the cavity of the ventricle by one side as it were, some are free between their attached extremities, and others again, generally the largest, send off delicate tendinous cords from their extremities (chordæ tendineæ) by which they are attached to the margins of the auriculo-ventricular valves.

The internal wall, or that presenting toward the opposite ventricle, is common to the two, and hence called the *interventricular septum;* its surface is convex upon the right and correspondingly concave upon the left side. The two openings communicating with the cavity are the right auriculo-ventricular and the pulmonary, and are both situated at its base, the latter in front and to the left of the former.

The *right auriculo-ventricular foramen*, communicating, as its name indicates, between the right auricle and ventricle, is very large, oval in form, and provided with a valve denominated the tricuspid. The *tricuspid valve* is formed of a doubling of the endocardium, strengthened by a little intervening fibrous tissue, and consists of three divisions, one of which is larger than the others. Each is irregularly triangular in shape, thin and translucent, and attached by one border to the circumference of the opening where the three divisions are continuous; the other borders sometimes present a nodulated appearance, and give insertion to the tendinous cords of the muscular bundles. The largest of the three divisions is situated upon the left side of the opening, and partly conceals from view the orifice of the pulmonary artery. The function of the tricuspid valve is to prevent the return of the blood into the auricle during the contraction of the ventricle. Thus, while the blood is passing through the opening from the auricle, the valve lies smoothly against the inner surface of the ventricle, the large division over the mouth of the pulmonary artery; but when the ventricle contracts, the valve is pressed outward by the blood as far as the tendinous cords will allow, which is just sufficient to close the opening, and to keep it closed until the ventricle relaxes and the weight of blood, which has in the mean time accumulated in the auricle, forces it back.

In front of the auriculo-ventricular opening, the cavity of the ventricle presents a sort of funnel-shaped prolongation obliquely upward and toward the left, at the termination of which is the *orifice of the pulmonary artery.* This opening is circular in shape, about three-fourths of an inch in diameter, and guarded by three valves called from their shape *sigmoid* or *semilunar*, or more properly, the *pulmonic valves.* These, like the

tricuspid, consist of a fold of the lining membrane and a small amount of inclosed fibrous tissue. They are crescentic or semilunar in shape, and placed side by side at the mouth of the artery, to which they are attached by their convex borders. Their free borders are slightly fenestrated; they contain at the centre a minute fibrous nodule, called the *Arantian body*, and, when the blood is passing from the ventricle, look in the direction of the artery. Behind the valves the artery presents a like number of slight enlargements, called the *pulmonic sinuses.* The function of the semilunar valves is to prevent the regurgitation of the blood during the filling of the ventricle, which they do by being forced out against one another in the axis of the orifice by the pressure of the blood, when the contraction of the ventricle ceases. From the right ventricle, the blood is sent to the lungs to be aerated, whence it is returned by the four pulmonary veins to the left auricle.

The **Left Auricle** (Fig. 230) is situated upon the base of the left ventricle and upon the left side of the right auricle. It is irregularly cuboidal in shape, and prolonged anteriorly in the form of a flattened constricted process, called the *auricular appendage*, which, when distended, overlaps the root of the pulmonary artery. Its interior (which may be exposed by incisions similar to those directed for opening the right auricle) is quite smooth, and almost destitute of that pectinate appearance noticed upon the inner surface of the right auricle. The oval fossa, existing upon the right surface of the interauricular septum, is wanting upon the left. The only points of great interest connected with the interior of this cavity are, the openings of the four pulmonary veins found at its four superior corners; the small constricted communication with the auricular appendage; and the large auriculo-ventricular opening below, which is better studied in connection with the ventricle.

The **Left Ventricle** (Fig. 230) is situated to the left of and behind the right ventricle, from which it is marked off upon the exterior by the interventricular grooves. It is almost regularly conoidal in shape, and, being somewhat longer than the right, projects beyond the latter to form the greater part of the apex of the heart.

Dissection.—To expose the cavity of the left ventricle, remove nearly the whole of its external wall by two longitudinal incisions made within half an inch of the two interventricular grooves, meeting at the apex, and joined above by a transverse one near the base, including thus a large triangular piece.

In making this dissection, it will be observed that the walls of the left ventricle are three or four times thicker than those of the right, a circumstance, which, as previously mentioned, is connected with the greater labor required of this cavity in sending the blood to all parts of the system; at the apex, however, they are very thin. The size of the cavity

is usually stated to be less than that of the right, but experiments, conducted in a manner to insure accuracy, have proved that if there is any difference at all, it is in favor of the left. It may be stated in a general way, therefore, that their capacities are about the same, although varying greatly in different individuals. The internal surface of the left ventricle presents the same reticulated appearance observed in the right, but the fleshy columns are generally smaller and more numerous, and the meshes or interspaces much closer. There are two exceptions, however to the general smallness of the muscular bundles, for upon the anterior and posterior surfaces are two fleshy columns much larger than any in the right cavity, from the summits of which are given off a large lash of tendinous cords that control the valve of the auriculo-ventricular opening. The internal or right wall of the cavity, formed by the interventricular septum, is concave.

The *left auriculo-ventricular opening* is nearly similar to the right in size and shape, and like it is provided with a valve, which is divided into two parts, and hence sometimes called the *bicuspid*, but more commonly the *mitral valve*, from the circumstance that the larger of its two divisions is shaped somewhat like a bishop's mitre. In structure, it is also similar to the tricuspid, but is much thicker and stronger, and provided with a greater number of tendinous cords. Its function is to prevent the return of the blood into the left auricle during the contraction of the ventricle; but the large division being placed just over the mouth of the aorta, is also supposed to perform an equally important office in preventing the blood from entering this vessel until the ventricle contracts, when the valve is pressed out to close the auriculo-ventricular opening. In connection with this, it may be mentioned that it is more than probable that the contraction of the heart is in a great measure brought about by the stimulus of distention, just as the bowel, for instance, is made to contract by the pressure of its contents. This distention could not occur if there were no obstacle to the free passage of the blood out of the cavity while being filled. The student will better understand this by cutting through the auriculo-ventricular opening, and spreading open the cavity, when he will observe that the mouth of the aorta is entirely covered up by the large mitral valve.*

The *aortic opening*, situated in front and to the right of the auriculo-ventricular, is almost perfectly circular in shape, and provided with three valves, called the *aortic*, *sigmoid* or *semilunar valves*, precisely like those at the mouth of the pulmonary artery, except probably that they

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* It may be objected to this theory of mechanical distention, that it does not hold good in reference to the right side; but this is not the case, for the largest of the three divisions of the tricuspid valve is placed directly over the entrance of the pulmonary artery, although it does not entirely conceal it. The distention of one side, however, is probably sufficient to induce contraction of both.

are thicker and stronger; the little nodule called the Arantian body, found in the middle of the free margin of each, is also somewhat larger. Behind these valves, the aorta is considerably dilated, forming as many pouches, called the *aortic sinuses*, in the upper part of two of which may be seen the mouths of the two coronary or cardiac arteries.

Structure of the Heart.—The heart is composed in a great measure of muscular tissue inclosed between an investing and a lining membrane. The investing membrane is the visceral layer of the serous pericardium already described.

The *Endocardium*, the lining membrane, is exceedingly thin and delicate, except where it is folded upon itself to form the valves; it is continuous with and similar in structure to the internal coat of the blood-vessels; and is somewhat thicker and more liable to disease upon the left than upon the right side.

The *Muscular Tissue* of the heart constitutes the great bulk of the organ. Its fibres are red, indistinctly striated, and are said to anastomose with each other, as represented in the accompanying figure. It is disposed in the form of bands or layers held together by an exceedingly delicate areolar tissue spreading over the auricles and ventricles, and arranged in a very intricate manner. All of the fibres, however, both of the auricles and ventricles, have their origin or fixed point of action in two fibrous rings surrounding the auriculo-ventricular openings, and connected with the valves that guard these orifices; the ring surrounding the left being the thicker and stronger of the two.

Fig. 231.

Striated muscular tissue of heart, highly magnified.

The fibres of the auricles consist of two sets, the one superficial, common to the two cavities; the other deep seated, and proper to each. The common fibres form a very thin and incomplete layer; they are for the most part directed transversely across the anterior and posterior surfaces, and are best seen near the junction of the auricles with the ventricles. The proper fibres are disposed separately in a looped or arched manner over the auricles, and attached by their extremities to the corresponding fibrous rings, excepting those upon the auricular appendages, which form a series of concentric circles around these cavities, and are prolonged for a short distance upon the cava and pulmonary veins.

The *fibres of the ventricles*, like those of the auricles, belong to two general divisions, one superficial and common to the two cavities, and the other limited to each. The common fibres form a succession of layers,

which, originating from the fibrous zones above mentioned, run in an oblique or spiral manner around the heart (those in front passing downward from right to left, and those behind from left to right), and turn inward to form the interventricular septum and fleshy columns. The proper fibres are both spiral and circular, but their arrangement has not been accurately determined.

Besides the fibrous rings forming the circumference of the auriculo-ventricular openings, two smaller ones are found at the pulmonary and aortic orifices, which give attachment on the one side to some of the muscular fibres of the ventricles, and, on the other, to the two corresponding arteries.

Vessels and Nerves.—The *coronary* or *cardiac arteries*, the nutritious arteries of the heart, are two in number, and originate from the aortic sinuses.* The *right*, the larger, passes forward between the origin of the pulmonary artery and base of the right auricle, and turning toward the right enters the auriculo-ventricular groove, which it follows to the back of the organ to inosculate with the left coronary. It gives off posteriorly a large branch that descends along the posterior interventricular groove, and is distributed to the muscular substance on each side as far as the apex. The *left* makes its appearance between the left auricle and the root of the pulmonary artery, and, after descending a little way, divides into two branches, one of which turns off to the left, enters the auriculo-ventricular groove, and inosculates with the right, while the other descends along the anterior interventricular groove to meet the descending branch from the right.

The *coronary vein*, the main trunk by which most of the venous blood from the walls of the heart is transmitted, commences by the confluence of numerous branches over the apex of the organ, ascends along the anterior interventricular groove as far as the junction between the auricles and ventricles, then turns off to the left, running along the auriculo-ventricular groove to the back part of the organ, where, having received a large number of branches, it becomes much enlarged, and terminates by perforating the lower back part of the right auricle.

The *lymphatics* of the heart are numerous, and for the most part accompany the coronary vessels. Those on the right unite at the base of

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* The mouths of the coronary arteries being situated behind the semilunar valves, it is probable that the blood does not enter them as it passes from the ventricle, but is driven into them by the elasticity of the aorta after the closure of the aortic valves; and this is still further proven by the fact that during the contraction of the ventricle it would be impossible for the blood to fill the coronary arteries. The pulse of these vessels then is the pulse of regurgitation, and alternate with that of every other artery in the body.

the organ in a common trunk, which passes over the arch of the aorta, then between the innominate and left common carotid arteries, and along the trachea to reach the right lymphatic trunk in the neck. Those from the left side also unite at the base of the heart to form a single vessel, which, passing along the pulmonary artery, ascends behind the arch of the aorta, and opens into the thoracic duct.

The *nerves* of the heart are branches from the sympathetic and pneumogastrics. The cardiac branches of the sympathetic come from the three cervical ganglia on each side, as heretofore described; these uniting with offsets from the main trunk of the pneumogastrics and their recurrent laryngeal branches, form the *cardiac plexus* which is situated upon the concavity of the arch of the aorta in front of the trachea. From this plexus, all parts of the organ are supplied.

THE BACK.

Although the Back, in a surgical point of view, is one of the least important regions of the body, it possesses some points of interest which should be carefully studied. Of these, the middle line or ridge formed by the spinous processes of the vertebræ is of the most practical value. By this, the surgeon judges the existence of fracture, dislocation, or curvature. Its direction is not generally perfectly straight; usually a slight lateral curvature, with its convexity presenting to the right, may be detected on a level with the shoulders, which is supposed to be caused by the bending of the body toward the left in lifting heavy weights or making other violent efforts with the right arm. In left-handed persons, Béclard found the curvature reversed. Not infrequently, a slight compensating curvature is observed in the lumbar region, with its convexity presenting toward the opposite side.

Beneath the skin of the back is a very thick firm layer of areolar tissue, which, if the subject has been lying some time, will be found filled and discolored with bloody serum. Underneath the areolar tissue are the muscles.

MUSCLES OF THE BACK.

The Muscles of the Back are very numerous, and arranged in several successive layers, of which six are generally recognized, but the number may be very conveniently reduced to four. In the first two or three layers, they are large and few in number, but next the bones they are very numerous, and many of them very small. In dissecting the latter it will be found that the attachments of many do not precisely correspond to the description; for in this respect there is the greatest variety. If the student in a first dissection and upon an adult subject succeeds in distin-

guishing all the small muscles of this region, he has reason to congratulate himself on his success; and it is hardly necessary to add that, to commit to memory their detailed origin and insertion, is as useless as it is difficult. Let him bear in mind, however, that these remarks have reference only to the deeper layers; the more superficial deserve a careful dissection.

FIRST LAYER OF MUSCLES.

The Superficial Layer of Muscles comprises but two on each side, the **trapezius and latissimus.**

Dissection.—Place the subject in a prone position with a block under the thorax and the arms hanging over the side of the table. The parts having then been sponged clean, make an incision through the skin extending over or close by the side of the spinous processes of the vertebræ, from the occiput to the first or second lumbar vertebra, and another from the seventh cervical vertebra transversely across to the acromion. The two flaps of skin may be now turned back and afterward the areolar tissue; or both the skin and areolar tissue may be removed together, dissecting as usual in the course of the subjacent muscular fibres, whose direction is seen in Fig. 232.

Having reflected the flaps so far as to display the whole extent of the trapezius muscle, the latissimus may be brought into view by extending the median incision nearly as far as the point of the sacrum, intersecting it by another along the posterior third of the iliac crest, and dissecting back the integument and subcutaneous areolar tissue in one layer.

The **Trapezius Muscle** (Fig. 232, $_1$), broad, flat, and triangular, arises from the posterior third of the superior curved line of the occiput, from the fibrous intersection called the *nucha ligament*,* stretched between the external occipital protuberance and the seventh cervical vertebra, and from the spinous processes of the last two cervical and all the dorsal vertebræ. From this extensive origin the fibres converge in the direction of the shoulder, and are inserted into the posterior border of the scapular third of the clavicle, external edge of the acromion, and the whole length of the upper lip of the spine of the scapula. The origin consists mostly of mixed tendinous and fleshy fibres, except that portion from the two lower cervical and three or four upper dorsal vertebræ, which is entirely tendinous, and forms with its fellow of the opposite side a long, oval-shaped, glistening surface in this situation. The insertion is also tendinous and fleshy, the lowermost fibres forming a flat triangular tendon,

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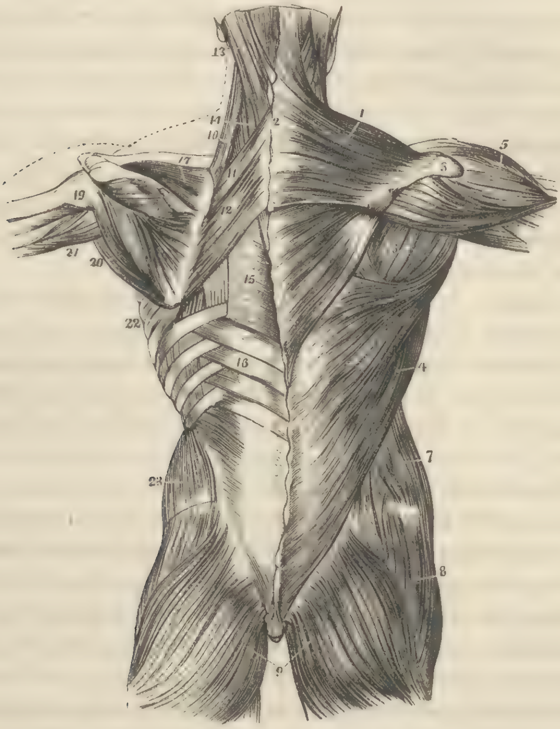
* The nucha ligament in some of the inferior animals, the ox and horse, for example, is a thick layer of yellow elastic tissue, called whit-leather, extending between the back of the head and the spinous processes of all the cervical and some of the dorsal vertebræ, and is intended to support the weight of the head; but in the human subject, the head being erect, no such structure is needed; and, hence, there is only a medium raphe or fibrous union between the muscles of the two sides in this situation. It is to this raphe that the term nucha ligament is improperly applied.

which glides over the root of the spine of the scapula, a synovial bursa intervening.

Use.—To elevate and carry the shoulder backward; or, if only the lowermost fibres act, to turn the glenoid surface upward by depressing the posterior superior angle.

Fig. 232.



First and second and part of third layer of muscles of back: first layer being shown on right and second on left side. 1, trapezius muscle; 2, tendinous portion of same, which, with corresponding portion of opposite muscle, forms a tendinous ellipse on lower part of back of neck; 3, acromion process and spine of scapula; 4, latissimus muscle; 5, deltoid; 6, infraspinous and small teres muscles; 7, external oblique abdominal muscle; 8, middle gluteal muscle; 9, great gluteal; 10, elevator of scapula; 11, 12, rhomboid muscles (small and large); 13, 14, splenius muscle; 15, aponeurosis covering spinal erector muscles; 16, inferior dorsal serrate muscle; 17, supraspinous muscle; 18, infraspinous muscle; 19, smaller teres muscle; 20, greater teres muscle; 21, long head of triceps muscle of arm; 22, part of great serrate muscle; 23, internal oblique abdominal muscle.

Relations.—The trapezius is covered only by the skin, subcutaneous areolar tissue, and a thin fascia. It lies upon several muscles of the second layer, and also overlaps the latissimus for a short distance where it originates from the lower dorsal vertebræ. At its anterior superior margin, the terminal branches of the spinal accessory nerve will be seen entering the muscle.

The **Latissimus** or **Dorso-humeral Muscle** (*latissimus dorsi*, Fig. 232, $_4$), very broad, thin, and triangular, crosses the whole of the lower part of the back and loins. It takes its origin from the spinous processes of the lower six or seven dorsal and all the lumbar vertebræ; from the spine of the sacrum, posterior third of the iliac crest, and the three lower ribs, indigitating here with the external oblique abdominal muscle. From all these points, the fibres curve around the trunk obliquely upward and forward, converging as they ascend; and, having reached the anterior border of the scapula, form with the greater teres muscle a large, rounded fleshy mass, which constitutes the posterior boundary of the axilla, and is inserted by a broad flat tendon into the inner or posterior edge of the bicipital groove of the humerus. Its origin from the ribs is fleshy, but that from the lumbar vertebræ, sacrum, and ilium is a very dense, strong, aponeurotic expansion, which is the posterior of the three layers of the lumbar fascia, and is the principal structure upon which the strength of this part of the body depends.

The flat tendon by which it is inserted into the humerus, although closely connected, is not blended with that of the greater teres muscle, but lies in front of it, and reaches a little higher upon the bone.

Use.—To depress the arm obliquely backward, and also to rotate it slightly inward; or, if the arm is elevated and fixed, its greatest power is displayed in elevating the body; and by its origin from the ribs it assists somewhat in dilating the thorax.

Relations.—The latissimus is covered by the integument and subcutaneous areolar tissue, and overlapped by the lower angle of the trapezius. It covers the lower part of the spinal erector muscle, the inferior posterior serrate muscle, the lower lateral part of the thorax, part of the rhomboid and great serrate muscles, and the lower angle of the scapula, over which last it glides, and from which it sometimes receives an additional fleshy slip. The axillary portion of the muscle is at first external to the greater teres muscle, but soon passes in front of it, and is in relation, by its anterior surface, with the axillary vessels and nerves.

SECOND LAYER OF MUSCLES.

The Second Layer of Muscles comprises the rhomboid, elevator of the scapula, superior and inferior posterior serrate, and splenius.

Dissection.—Remove the trapezius by cutting it from its origin and turning it outward. Divide the latissimus transversely just below the lower angle of the scapula, and dissect down the lower segment to the point where it forms the lumbar aponeurosis, and there cut it off. The reason for leaving the aponeurosis is that the inferior serrate muscle originates from its under surface.

The **Rhomboid Muscle** (Fig. 232, $_{12}$), broad, thin, and quadrilateral, arises from the four or five upper dorsal and two lower cervical spines,

and from the lower extremity of the nucha, passes outward and a little downward, and is inserted into the whole length of the posterior border of the scapula, indigitating here with the insertion of the great serrate. That portion of the muscle which originates from the two lower cervical vertebræ and nucha, and is inserted above the root of the spine of the scapula, is commonly called the *smaller rhomboid*, to distinguish it from the larger portion below, called the *greater rhomboid*, from which it is separated by an areolar interspace.

Use.—To draw the shoulder backward and a little upward; or, if only the lowermost fibres act, to rotate the scapula by drawing its lower angle backward.

Relations.—By its superficial surface, it is in relation with the trapezius above and the latissimus below, and, in a triangular space between these two near the scapula, with the integument and subcutaneous areolar tissue; by its deep surface, with the superior serrate and spinal erector muscles.

The **Elevator of the Scapula** (*levator anguli scapulæ*, Fig. 232, $_{10}$), long, flat, and narrow compared with the preceding, is situated upon the posterior and lateral part of the neck. It arises by tendinous slips from the posterior tubercles of the transverse processes of the four or five upper cervical vertebræ; descends a little outward and backward, and is inserted into the superior angle of the scapula.

Use.—To elevate the shoulder, at the same time assisting the rhomboid in rotating the scapula by drawing upon its superior angle.

Relations.—By its external border, with the trapezius and sternomastoid; behind, with the splenius; and in front, with the scalene muscles.

The **Posterior Serrate Muscles**, two in number, very thin and quadrilateral, are situated, one upon the upper, and the other upon the lower part of the back of the thorax. They are continuous with each other by an aponeurotic expansion (vertebral aponeurosis), which stretches from the spinous processes of the dorsal vertebræ beyond the angles of the ribs, and extends in a vertical direction from the lower edge of one muscle to the upper edge of the other. The *superior* (serratus posticus superior) arises by a delicate aponeurosis from the upper dorsal and two lower cervical spines, and passes outward and downward to form a flat fleshy belly, which is inserted by separate slips into the upper borders of the second, third, and fourth ribs, just beyond their angles. It is covered by the rhomboid, and lies upon the spinal erector muscles. The *inferior* (serratus posticus inferior, Fig. 232, $_{16}$), also very thin, but broader than the preceding, arises in the same manner from the under surface of the aponeurotic origin of the latissimus, opposite the two lower dorsal and

two upper lumbar vertebræ, passes outward and upward, and is inserted by fleshy slips into the lower borders of the four inferior ribs just beyond their angles. It is covered entirely by the latissimus, and lies upon the lumbar portion of the spinal erector muscles.

Use.—The two posterior serrate muscles are muscles of respiration, but are opposed to each other; the superior assists inspiration by elevating the ribs and thus dilating the thorax, and the inferior aids in expiration by drawing the ribs down.

Dissection.—Detach the posterior serrate muscles and connecting aponeurosis from their attachment to the spine, turn them outward, and cut them close to the ribs.

The **Splenius Muscle** (Fig. 232, $_{13}$) is long, flat, and somewhat triangular, and situated obliquely upon the back part of the neck. It arises from the five or six upper dorsal and two lower cervical spines, and adjacent extremity of the nucha, ascends obliquely outward, and is inserted by tendinous slips into the transverse processes of the three or four upper cervical vertebræ behind the attachment of the elevator of the scapula, into the external portion of the rough surface between the two curved lines of the occipital bone, and into the back part of the mastoid process. Between that portion inserted into the transverse processes and that into the head, a slight areolar interval exists, which gave rise to the old division into two muscles, called respectively the *splenius colli* and *splenius capitis.*

Use.—To bend the head and neck backward and to one side, and to rotate the head in the corresponding direction; the muscles of both sides acting, the head and neck are bent directly backward.

Relations.—By its superficial surface, it is in relation with the rhomboid and superior serrate below, and elevator of the scapula and sterno-mastoid above; by its deep surface, with the numerous deep muscles of the back of the neck.

THIRD LAYER OF MUSCLES.

The Third Layer of Muscles consists of the spinal erector and complexus.

The **Spinal Erector Muscle** (*erector spinæ*) is situated in the deep gutter by the side of the spinous processes of the vertebræ, and extends nearly the whole length of the trunk. It divides as it ascends into a number of parts, commonly considered as separate muscles, and named respectively the sacro-lumbal, longissimus, spinalis, ascending cervical, transverse cervical, and trachelo-mastoid. The muscle commences by a pointed origin in the deep groove found between the spine of the sacrum

and the posterior part of the iliac crest, originating from the bony surface upon which it rests, and is closely covered in by the aponeurotic origin of the latissimus. In the lumbar region, it presents itself in the form of a thick, rounded, fleshy mass, bound down behind by the aponeurosis of the latissimus, and attached in front to the transverse and articulating processes of the lumbar vertebræ. Near the twelfth rib, this mass divides into two lateral parts, of which the external is the sacro-lumbal, and the internal the longissimus and spinalis.

The *Sacro-lumbal*, the larger division, ascends a little outward upon the back of the thorax, narrowing as it ascends, and is inserted by long tendinous slips into all the ribs near their angles. By raising its inner margin and turning it outward, a tendinous slip will also be found to originate from the angle of each successive rib, and to pass obliquely upward to the under surface of the muscle, constituting what is called the *accessory muscle.*

The *Longissimus* ascends by the side of the spinous processes of the dorsal vertebræ, but is separated from them by the spinalis. It is inserted by fleshy and tendinous slips into the transverse processes of all the dorsal vertebræ, and into all the ribs between their tubercles and angles.

The *Spinalis* (spinalis dorsi) lies on the inner side of the preceding, and is with difficulty distinguished from it. Considered as a separate muscle, it arises from the lateral surfaces of the two upper lumbar and two or three lower dorsal spines, ascends, and is inserted into the eight or nine superior dorsal spines.

The *Ascending Cervical* (cervicalis ascendens or descendens) is a continuation of the sacro-lumbal. It arises from the three or four superior ribs between their tubercles and angles, ascends, and is inserted by tendinous slips into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ, between the tendons of the cervical portion of the splenius and the elevator of the scapula, with both of which it is more or less blended.

The *Transverse Cervical* (transversalis colli) is small, and with difficulty separated from the preceding. It is the cervical continuation of the longissimus. It arises from the transverse processes of the three or four lower cervical vertebræ, and is inserted by tendinous slips into the transverse processes of the three or four upper cervical vertebræ.

The *Trachelo-mastoid*, also a continuation of the longissimus, lies upon the inner side of the preceding, and is somewhat blended with it at its origin. It arises from the transverse processes of the two or three upper dorsal and three or four lower cervical vertebræ, ascends a little outward, and is inserted into the back of the mastoid process.

Use.—To keep the trunk erect, and to bend the spine in the different directions indicated by the course of the different divisions of the muscle.

The **Complex Muscle** (*complexus*), exposed by the removal of the splenius, is large, thick, and elongated. It is situated in the upper back part of the neck next to the nucha, and forms the rounded vertical ridge on each side, separated by a superficial median furrow. It arises from the transverse processes of the five or six superior dorsal and three or four lower cervical vertebræ, ascends vertically by the side of its opposite fellow, but separated from it by the fibro-areolar raphe or nucha ligament, and is inserted into the inner half of the rough surface included between the two curved lines of the occiput. The muscle contains two or three tendinous intersections, which give it a very beautiful appearance when neatly dissected and put upon the stretch.

Use.—To throw the head backward.

FOURTH LAYER OF MUSCLES.

The Fourth Layer of Muscles comprises the transverso-spinal, interspinal, supraspinal, intertransverse, transverso-costal, and the oblique and posterior straight muscles of the head.

Dissection.—Remove the whole of the spinal erector and complexus of one side, and dissect off the intermuscular fascia.

The Transverso-spinal Muscles.—Under this name are included the muscles usually described as three separate classes; namely, the Semispinalis Colli, Semispinalis Dorsi, and Multifidus Spinæ. They consist of a series of muscular and tendinous fasciculi attached by one extremity to the transverse processes of the vertebræ, and by the other to the second or third spinous processes above. They occupy the deep part of the dorsal groove, and extend from the occiput to the sacrum, varying in shape and size in the different regions. Thus, in the loins, they arise from the back part of the transverse and articular processes by flat, tendinous slips, pass upward and inward, and are inserted fleshy into the spinous process of each vertebra above. In the thoracic region, they arise by long slender tendons from the transverse processes of the lower dorsal vertebræ, ascend obliquely, and are inserted in the same manner into the superior dorsal spines. In the neck, the muscle is very large, and fills up nearly the whole of the groove by the side of the spinous processes; the fasciculi, which are very numerous, and placed one above another, arise from the transverse processes of the five or six superior dorsal and the oblique processes of the four or five lower cervical vertebræ, and are inserted into the spinous processes of all the cervical vertebræ as high as the second.

Use.—To support each vertebra in its place, to bend the spine to one side, and to rotate in an opposite direction. When the muscles of both sides act, the spine is bent directly backward.

The **Interspinal Muscles** are situated, as their name implies, between the spinous processes, and vary in size in the different regions, according to the extent of the intervals between these processes. They are most distinct in the cervical region, where they may be seen to consist of two lateral bundles between each two vertebræ.

Use.—To assist in bending the spine backward.

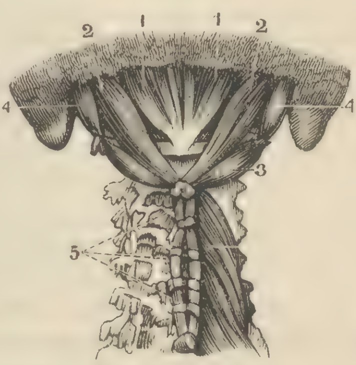
The **Supraspinal Muscles** are small, and often with difficulty distinguished as separate muscles. They extend from the summit of each spinous process to the first, second, or third above.

The **Intertransverse Muscles** are small, fleshy bundles, extending between the transverse processes of the adjacent vertebræ.

Use.—To bend the spine in a lateral direction.

The **Transverso-costal Muscles** (*levatores costarum*) are a very beautiful set of little fan-shaped muscles, twelve upon each side, which originate from the summits of the transverse processes of the dorsal vertebræ, and are inserted into the rough surface of the rib below, between its tubercle and angle.

Fig. 233.



Deep posterior spinal muscles. 1, small, 2, large, posterior straight muscle of head; 3, inferior, 4, superior, oblique muscle of head; 5, interspinal muscles.

The **Posterior Straight Muscles of the Head** (*recti capitis postici*, Fig. 233), two in number, are situated beneath the complex, and surrounded by a considerable quantity of areolar tissue. The larger one[2] arises from the spinous process of the axis, and is inserted into the outer part of the rough surface, between the curved lines of the occipital bone. The smaller[1] arises from the tubercle upon the posterior arch of the atlas, and is inserted into the occipital bone upon the inner side of the preceding. The larger muscle is not straight, but oblique.

Use.—To throw the head backward, and, when only the larger muscle of one side acts, to rotate the head in the corresponding direction.

The **Oblique Muscles of the Head** (*obliquus capitis, o. superior, o. inferior*, Fig. 233) are situated beneath and external to the preceding. The *superior* or *atlanto-occipital*,[4] the smaller of the two, arises from the transverse process of the atlas, ascends inward and backward, and is inserted into the occipital bone just behind the mastoid process. The *in-*

ferior or *atlanto-axoid*[3] is larger than the preceding, and of a rounded form. It arises from the spinous process of the second vertebra, passes upward, outward, and forward, and is inserted into the extremity of the transverse process of the atlas.

Use.—The superior inclines the head toward the corresponding side, and throws it slightly backward. The inferior is the special muscle by which we are enabled to rotate the head to one side or the other without turning the whole trunk; it acts from the axis upon the atlas, which latter always carries the head with it in rotation.

The *Vessels* and *Nerves* met with in dissecting the back are generally very small, and an account of their distribution does not, therefore, come within the scope of an elementary work.

THE SPINAL CORD.

The Spinal Cord is the long, narrow, cylindrical part of the cerebro-spinal axis that occupies the spinal or vertebral canal. Unlike the brain it does not correspond in size to the cavity which contains it, but is separated from the walls of the canal by a considerable interval, which is occupied by the membranes, spinal fluid, and a quantity of areolar and adipose tissue. The membranes will first engage attention.

Dissection.—The spinal canal may be opened either in front or behind, but the latter situation is most convenient. Dissect the muscles from the long gutter upon each side of the spine, and with a small saw proceed to divide the laminæ of each vertebra as near the articulating process as possible, taking care that the point of the saw does not injure the cord or its membranes. This division should be carried from the sacrum to the occiput, and the long narrow section, composed of the spinous processes and laminæ, carefully removed.

The spinal cord is covered by continuations of the Membranes that surround the brain, having the same general arrangement.

The Dura Mater.—The spinal portion of the dura mater extends from the occipito-spinal foramen to the termination of the sacral canal. It corresponds very nearly, both in shape and size, to the vertebral canal, and opposite the intervertebral foramina sends off tubular prolongations upon the nerves which leave the canal at these points. Its external surface is firmly connected to the margin of the large opening in the occipital bone, and the tubular prolongations to the margins of the intervertebral foramina, but in the rest of its extent it is separated from the bony walls by a venous plexus, and a variable quantity of soft, reddish, adipose tissue. Its internal surface is smooth and glistening, being lined by the parietal portion of the arachnoid.

The Arachnoid.—The spinal, like the cranial portion of the arachnoid membrane, consists of a parietal and visceral layer.

The *parietal layer* lines the inner surface of the dura mater, with which it is intimately blended. It is prolonged for a short distance into the tubular sheaths of the nerves given off by the dura mater, and is there continuous with the visceral layer, which covers the spinal portion of these nerves.

The *visceral layer* is not in immediate contact with the surface of the cord, but is separated from it by a considerable space (subarachnoid space), which is occupied by loose areolar tissue and a quantity of serous fluid. It covers the roots of the nerves as far as the intervertebral foramina, where it is reflected off, to become continuous with the parietal layer lining the tubular processes of the dura mater.

The cavity of the arachnoid sac in the spinal canal is a continuation of the same in the cranium ; its opposite walls are always in contact, and kept moist by a serous exhalation that bedews the surfaces and prevents injurious friction in the movements of the spinal column.

The *subarachnoid space*, the interval between the visceral layer of the arachnoid membrane and the cord, is continuous above with the same space upon the brain, upon whose base, it will be recollected, this interval is of considerable size. It is occupied, as above mentioned, by loose areolar tissue, and by a certain amount of serous fluid, in which the cord may be said to be suspended. The quantity of fluid, as ascertained by Cotunnius, varies from four to five ounces, and its use seems to be to protect the cord in the different movements of the vertebral column; but it also seems to be essential to the proper performance of the functions of the latter. Thus, when suddenly drawn off from a dog, the animal drops instantly upon the ground, and remains in an apparently lifeless condition, until sufficient time elapses for its reaccumulation, when he gets up and walks off, as though nothing had happened.*

The Pia Mater.—The spinal, unlike the cranial portion of the pia mater, is a dense, strong, fibrous membrane, which surrounds the cord so closely that, when an incision is made into it, the substance of the cord protrudes beyond the cut surface. It is frequently called the *neurilemma* of the cord. Its rough filamentous exterior connects it to the visceral layer of the arachnoid by means of the subarachnoid areolar tissue, and gives off several thin, triangular, toothlike processes (*dentate ligaments*), which pass transversely outward, to be attached to the dura mater in the intervals between the tubular prolongations of this membrane. The number of these processes is about twenty on each side, and their use is to fix the cord in the centre of the canal. Belonging properly to this same series of processes is the small rounded fibrous filament, that descends the canal from the extremity of the cord to be attached to the posterior surface of the coccyx.

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* Cruveilhier.

The **Spinal Cord** is from fifteen to eighteen inches in length, and extends from the lower termination of the medulla oblongata at the occipito-spinal foramen to about opposite the junction of the first and second lumbar vertebræ, where it ends in a blunt conical point. It is cylindrical in shape, and flattened in an antero-posterior direction. It is not, however, of the same size throughout, but presents two slight enlargements, one in the lower part of the cervical, and the other in the lower part of the dorsal region; below the latter it gradually narrows to its termination. The former of these swellings corresponds to the origin of the nerves of the superior extremity, and the latter to those of the inferior. The space between the cord and the walls of the spinal canal is occupied by the structures previously mentioned, and by the origins of the nerves; the canal below the termination of the cord is filled by the large lash of nerves called the *mare's tail* or *cauda equina*, composed of the sacral and lower lumbar nerves on their way to the foramina through which they leave the canal.*

The spinal cord is composed exteriorly of white or medullary substance, and internally of a small central column of gray substance. When freed of its membranes, it will be observed to be marked by two longitudinal fissures, called, from their situation, the anterior and posterior median fissures. They extend the whole length of the organ, dip deeply into its substance, and divide it into two lateral halves or columns.

The *anterior median fissure*, more apparent than the posterior, penetrates about one-third the thickness of the cord, and is occupied by a prolongation of the pia mater; at its bottom, the two lateral halves of the cord are continuous by means of a thin layer of medullary substance called the *anterior commissure.* The *posterior median fissure*, although not so plainly seen as the anterior, is deeper; it is occupied by a prolongation of the dura mater, and its bottom is formed by the gray substance, which is here called the *posterior commissure.*

Besides the anterior and posterior median fissures, the spinal cord presents two longitudinal grooves upon the surface of each lateral half, corresponding to the anterior and posterior origins of the spinal nerves, and called the *anterior* and *posterior lateral grooves;* but of these only the posterior penetrates into the substance of the cord. By these lateral grooves each half of the cord is divided into three longitudinal columns, an anterior, a posterior, and a lateral. The anterior are motor, the posterior are sensory, and the lateral are probably composed of both motor and sensory fibres.

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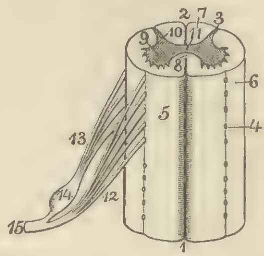
* In early fœtal life, the spinal cord occupies the whole length of the canal, but the latter becoming more rapidly developed than the former, the sacral and lower lumbar nerves become correspondingly elongated from their origin to the foramina by which they emerge from the canal.

Structure.—The spinal cord, as already remarked, consists of gray and white nervous substance, the latter inclosing the former.

The *gray matter* of the cord forms a single column, occupying the centre or axis of the organ from one end to the other. Its arrangement, which is very peculiar and interesting, and its relative proportion at different points, may be ascertained by making a series of transverse sections upon a perfectly fresh specimen. The cut surfaces thus made will be found to present two lateral crescentic forms of gray neurine, whose convexities present toward each other, and are continuous across the middle line. The anterior extremity or horn of each of these crescents is thick and rounded, and directed toward the line formed by the origins of the anterior roots of the spinal nerves, but does not quite reach the surface of the cord. The posterior horns are long and slender, proceed backward and outward, and terminate in a slight enlargement at the bottom of the lateral fissures corresponding to the origins of the posterior roots of the nerves. The transverse mass of gray matter which connects the convexities of the crescents is called the gray commissure; it is concealed from view at the bottom of the anterior median fissure by a layer of medullary substance called the anterior commissure, but is uncovered at the bottom of the posterior fissure, forming there the posterior commissure.

Fig. 234.



Segment o spinal cord. 1, anterior median fissure; 2, posterior median fissure; 3, postero-lateral fissure; 4, antero-lateral fissure; 5, anterior column; 6, lateral column; 7, posterior column; 8, anterior commissure; 9, anterior horns of gray substance; 10, posterior horns; 11, gray commissure; 12, anterior root of spinal nerve springing by number of filaments from antero-lateral fissure; 13, posterior root from postero-lateral fissure; 14, ganglion on posterior root; 15, spinal nerve formed by union of two roots.

The relative proportion of the gray neurine of the cord to the white substance by which it is surrounded is said to be as one to eight, but it varies somewhat at different points, being greatest in the lower part of the dorsal and lumbar regions, and least in the middle and upper part of the dorsal. At the extremity of the cord, the double concentric arrangement is entirely lost, and the gray matter is collected into a central mass with indented edges.

In the spinal cord of fishes, reptiles, and birds, a small central canal traverses the whole length of the organ, and communicates above with the fourth ventricle of the brain. In the human embryo a similar canal is also said to exist, but it is obliterated shortly before or immediately after birth.

The *medullary* or *white substance* of the spinal cord is situated exte-

rior to the gray, and consists of longitudinal fibres continuous, on the one hand, with the spinal nerves, and, on the other, with the medullary substance of the brain. The existence and disposition of these fibres may be demonstrated by tearing a cord that has been hardened in alcohol, or by placing a perfectly fresh specimen under a small stream of water directed upon it from a considerable height. In this manner, the bundles of fibres may be readily separated. It will then be found that the lateral halves of the cord interchange fibres only in the medulla oblongata, the so-called anterior and posterior commissures not forming true decussations, as their names would seem to indicate.

The white nerve fibres, of which the anterior, lateral and posterior columns of the spinal cord are composed, are supposed to be entirely independent of each other. Their office is to conduct impressions from the brain to the nerves, with which they are in a great measure continuous, and conversely from the nerves to the brain. Other fibres, however, than those continued from the nerves to the brain have been demonstrated as passing from one part of the cord to another, forming a connection between its different parts somewhat analogous to the antero-posterior fibres of the brain. It is now tolerably well established that some of the fibres forming the origins of the nerves do not extend to the brain, but begin or terminate in the cells of the gray neurine. Hence it is that the cord possesses a certain power independent of the brain, as exhibited by the movements of decapitated animals upon the application of irritants to the surface.

Origins of the Spinal Nerves.—The Spinal Nerves form thirty-one separate and distinct pairs, which, with one or two exceptions, leave the canal at the intervertebral and sacral foramina. They are called after the divisions of the spinal column, cervical, dorsal, lumbar, etc.; the cervical group comprising eight pairs, the dorsal twelve, the lumbar five, the sacral five, and the coccygeal one. The first two cervical nerves do not pass through the intervertebral foramina, but over the laminæ of the corresponding vertebræ. The coccygeal nerve emerges at the termination of the sacral canal.

Each spinal nerve originates from the side of the cord by two distinct roots, called from their relative position the anterior and posterior roots; of these, the former is entirely motor and the latter sensory in its function. The anterior or motor root is the smaller, and takes its origin opposite the anterior horn of the gray neurine, whence it passes outward to the corresponding intervertebral foramen. The posterior or sensory root originates from the posterior lateral fissure opposite the posterior horn of the gray crescent, and passes outward in the same manner to the intervertebral foramen. The two roots, therefore, converge from their origin, perforate the dura mater together, and, having traversed the same inter-

vertebral foramen, unite to form a single cord, which is consequently compound in its structure. Besides its greater size, the sensory root presents an oval enlargement or ganglion, which occupies the intervertebral foramen, immediately beyond which the union of the two roots occurs. The motor root, although lying in immediate contact with the anterior surface of the ganglion, has no communication with it.

The spinal cord being considerably shorter than the spinal canal, the origins of the nerves are necessarily closer than the intervertebral foramina, so that the length and obliquity of the roots gradually increase from above downward, and, in the lower dorsal and lumbar regions, the roots become so crowded together as to entirely conceal the cord from view. Those of the lower lumbar, sacral, and coccygeal nerves are the longest of the series. They descend almost vertically from their origin to their exit, and form the large lash called the *mare's tail* or *cauda equina.* Notwithstanding the great length of these nerves within the spinal canal, their anterior and posterior roots do not unite until they reach their respective foramina, within which the sensory roots form their ganglia. The last or coccygeal nerve is an exception; its ganglion occurs within the sacral canal, and its two roots unite before their exit.

The compound nerves, formed by the union of the motor and sensory roots of the spinal nerves, having passed the intervertebral foramina, divide immediately into an anterior and a posterior set of branches. The *posterior* divisions are generally very small, and are intended for the skin and muscles situated along the posterior aspect of the spinal column. The first and second cervical nerves are exceptions, their posterior branches being much the larger. The *anterior* divisions are distributed to the numerous parts situated in front of the vertebral column, including the superior and inferior extremities. They are, with the exceptions just mentioned, much larger than the posterior, and communicate at their exit with the sympathetic nerve, as represented in Fig. 222.

THE SUPERIOR EXTREMITIES.

The Superior Extremity, on each side, is connected to the trunk by the sterno-clavicular articulation and by nine separate muscles, of which two are inserted into the clavicle, namely, the sterno-mastoid and subclavian; two into the humerus, the great pectoral and latissimus; four into the scapula, the elevator of the scapula, rhomboid, omo-hyoid, and great serrate; and one into both scapula and clavicle, the trapezius. These having been already studied, the student may detach one limb at the sterno-clavicular articulation, and proceed to dissect its muscles, leaving the other connected with the trunk for the special study of the vessels and nerves.

The Muscles of the Superior Extremity, excluding the nine which act upon it from the trunk, are fifty in number, and may be classified as follows:

MUSCLES OF THE SUPERIOR EXTREMITY.

I. REGION OF THE SHOULDER.

One Class—(*Movers of the Arm. Six Muscles.*)*

Deltoid, Supraspinous, Infraspinous, Small and Large Teres, and Subscapular.

II. REGION OF THE ARM.

First Class—(*Mover of the Arm.*) *One Muscle*, Coraco-brachial.

Second Class—(*Movers of the Forearm*)—Two Groups.

First Group—*Flexors*	1. Biceps. 2. Anterior Brachial.
Second Group—*Extensors*	1. Triceps. 2. Anconeus.

III. REGION OF THE FOREARM.

First Class—(*Movers of the Forearm*)—Two Groups.

First Group—*Pronators*	1. Round pronator. 2. Square pronator.
Second Group—*Supinators*	1. Long radial supinator. 2. Short radial supinator.

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* The action of these muscles is so complicated as to forbid their arrangement into groups.

SECOND CLASS—(*Movers of the Hand*)—TWO GROUPS.

First Group—*Flexors*	1. Radio-carpal flexor. 2. Ulno-carpal flexor. 3. Middle carpal flexor.
Second Group—*Extensors*	1. Long radio-carpal extensor. 2. Short radio-carpal extensor. 3. Ulno-carpal extensor.

THIRD CLASS—(*Movers of the Fingers*)—TWO SUBCLASSES.

FIRST SUBCLASS—(*Movers of all the Fingers*)—TWO GROUPS.

First Group—*Flexors*	1. Superficial flexor of the fingers. 2. Deep flexor of the fingers.
Second Group—*Extensor*	Common extensor of the fingers.

SECOND SUBCLASS—(*Movers of Individual Fingers*)—TWO GROUPS.

First Group—*Flexor*	Long flexor of the thumb.
Second Group—*Extensors*	1. Extensor of the metacarpal bone of the thumb. 2. Extensor of the first bone of the thumb. 3. Extensor of the second bone of the thumb. 4. Extensor of the index finger. 5. Extensor of the little finger.

IV. REGION OF THE HAND.

FIRST CLASS—TWO GROUPS.

First Group	Short palmar.
Second Group	The four lumbricals. The seven interosseous.

SECOND CLASS—THREE GROUPS.

First Group	1. Abductor of the thumb. 2. Opponens of the thumb. 3. Short flexor of the thumb. 4. Adductor of the thumb.
Second Group	Abductor of the index finger.
Third Group	1. Abductor of the little finger. 2. Short flexor of the little finger. 3. Adductor of the little finger.

REGION OF THE SHOULDER.

Dissection.—The upper extremity having been detached from the trunk as directed, place a block beneath the arm near the axilla, so as to put the deltoid muscle on the stretch, and make an incision from the cut edge of the skin near the acromion down to the anterior aspect of the arm, as far as its middle. Next, dissect back the two flaps of skin and areolar tissue in the direction of the muscular fibres, and cut them off.

The **Deltoid Muscle** (Figs. 232, $_5$, and 235), situated immediately below the top of the shoulder and directly over the scapulo-humeral articulation, is large, thick, and triangular, convex upon its cutaneous

surface, and concave underneath. It arises by tendinous and fleshy fibres from the anterior border of the outer third of the clavicle, the outer border of the acromion, the lower edge of the spine of the scapula, and the aponeurosis covering the infraspinous muscle, and is inserted by a pointed extremity, consisting of short, strong, tendinous fibres, into the whole of the rough V-shaped eminence upon the outer anterior surface of the humerus just above its middle. The fibres from the acromion pass outward, and then vertically downward; those from the clavicle downward and backward; and those from the spine of the scapula downward and forward. The muscle, from the large size of its fleshy bundles, has a remarkably coarse appearance, not unlike that of the great gluteal; and when cut into will be found to contain numerous vertical and oblique tendinous bands, from which many accessory fleshy fibres take their origin.

Use.—The principal action of the deltoid is to elevate the arm, in which it is very slightly assisted by the supraspinous muscle. The anterior and posterior fibres may also carry the limb alternately backward and forward. When the arm is in a vertical position, the muscle, continuing to act, presses the head of the humerus downward, and thus favors its dislocation into the axilla.

Fig. 235.

Deltoid muscle. 1, body of muscle; 2, its origin from clavicle; 3, its origin from spine of scapula; 4, its insertion into humerus.

Relations.—The origin of the deltoid corresponds to, or, more properly, is directly opposite the insertion of the trapezius. Its insertion occupies an angular interval in the upper extremity of the anterior brachial muscle. Its outer or convex surface is covered by the integument and a thin fascia, and overlapped above by the origin of the platysma. Its under surface is in relation with the tendon of the great pectoral muscle, the upper portion of the humerus, the capsular ligament of the shoulder joint (a synovial bursa intervening), the acromion process, the insertion of the small pectoral, the origins of the coraco-brachial and biceps, and the insertions of the subscapular, supraspinous, infraspinous, and small teres muscles. Its anterior border is in contact with the biceps and the outer border of the great pectoral, but is separated from the latter near the clavicle by a small triangular interval, below which, and occupying the groove between the two muscles, the cephalic vein may be seen. Its posterior border is connected to the triceps and large teres muscles by a strong aponeurosis.

Dissection.—Cut the deltoid from its origin and turn it down, and dissect the areolar tissue and fascia from the surface of the muscles upon the back of the scapula. The *supraspinous fascia* is a strong fibrous membrane stretched across the fossa of the same name, and connected by its under surface to the supraspinous muscle. The *infraspinous fascia* covers the muscles on the back of the scapula below the spine, and is closely connected to the posterior border of the deltoid muscle.

The **Supraspinous Muscle** (Fig. 236, 1) occupies the supraspinous fossa upon the back of the scapula, to which it very nearly corresponds in shape. It arises from the bony surface upon which it rests, and from the under surface of the supraspinous fascia, passes outward beneath the acromion, and is inserted into the upper surface of the greater tuberosity of the humerus. It is covered above by the trapezius muscle and coraco-acromial ligament, and is in relation behind with the suprascapular nerve and artery, and the origin of the omo-hyoid muscle. Its most important relation, however, is with the shoulder joint, with whose capsular ligament it is so closely blended as to render their distinction almost impossible.

Fig. 236.

Muscles of dorsal surface of scapula. 1, supraspinous muscle 2, infraspinous; 3, small teres; 4, large teres.

The **Infraspinous Muscle** (Fig. 236, 2), flattened and triangular, arises from the under surface of the spine of the scapula and the posterior two-thirds of the dorsal surface of the bone below the spine. Its fibres pass upward and outward, and converge to a strong tendon, which glides beneath the concave border of the spine of the scapula below the acromion, becomes intimately connected with the capsular ligament of the shoulder joint, and is inserted into the middle surface of the greater tuberosity of the humerus.

Relations.—It is covered by the infraspinous fascia, overlapped above by the deltoid muscle, below by the latissimus, and behind by the trapezius, and, in the small triangular space between these three muscles, is separated from the skin only by the fascia. Its lower border is in close apposition, throughout its whole length, with the small teres, but is separated from it by a thin process of the investing fascia.

The **Small Teres Muscle** (*teres minor*, Fig. 236, 3), small and round, as its name indicates, is situated immediately below the preceding, and is

in close connection with it. It arises from the ridge and depression upon the anterior portion of the dorsal surface of the scapula, and from the aponeurotic septa separating it from the large teres and infraspinous muscles, between which it is placed ; it ascends obliquely outward along the lower border of the latter, and is inserted, by a short thick tendon, into the lower surface of the greater tuberosity of the humerus.

Relations.—It is covered below by the fascia and skin, overlapped above by the posterior border of the deltoid, and closely connected to the lower border of the preceding muscle; its outer border is at first in apposition with the large teres, but is separated from it above by the long head of the triceps extensor of the forearm. Its tendon, like that of the preceding, is intimately connected with the capsular ligament.

The **Large Teres Muscle** (*teres major*, Fig. 236, $_4$), situated below the preceding, is much larger, and of a more flattened form. It arises from the dorsal surface of the scapula, close to the inferior angle of the bone, and from the intermuscular aponeurotic septa, ascends outward and forward, forming part of the posterior boundary of the axilla, is inserted by a broad, flat tendon, into the posterior border of the bicipital groove of the humerus, behind the insertion of the latissimus, and extends a little lower down upon the arm.

Relations.—It is slightly overlapped at its origin by the latissimus muscle, which crosses its lower border obliquely from behind, and rises in front of it before reaching the humerus; its upper border is at first in relation with the small teres, but is afterward separated from it by the long head of the triceps, and is in contact with the lower border of the subscapular; in the interval between the biceps, latissimus and small teres, the muscle is subcutaneous.

The **Subscapular Muscle**, flat and triangular, occupies the subscapular fossa, from the whole of whose surface it takes its origin. It passes upward, outward and forward, its fibres converging, glides over the smooth pulleylike surface between the root of the coracoid process and glenoid cavity, and ends in a very thick short tendon, which forms a part of the capsular ligament in this situation, and is inserted into the smaller tuberosity of the humerus and adjacent surface of the bone for a short distance below.

Relations.—The posterior surface of the muscle is in contact with the surface of the bone from which it originates, and the ramifications of the subscapular artery; its deep surface lies upon the great serrate muscle, a thin fascia intervening, and is in relation, near its insertion, with the axillary vessels and nerves; its inferior border is in contact with the large teres. The tendon of the muscle is separated from the neck of the scapula by a large bursa, and beyond this point is continuous above and below with the capsular ligament, and is lined internally by the synovial membrane, which most frequently communicates with the bursa.

The supraspinous, infraspinous, small teres, and subscapular muscles being inserted into the humerus very close to the shoulder joint, which is the fulcrum of a lever of the third kind, cannot be of very great service in making those powerful and extensive movements of which the upper extremity is capable. Their function, however, is a very important one, and consists mainly in keeping the head of the humerus in place. This they do by pressing it firmly upon all sides, and presenting a strong tendinous barrier to its displacement in almost every direction. The infraspinous and small teres also rotate the arm outward, while the subscapular rotates it inward. The large teres assists the latissimus in drawing the arm downward and backward, and rotating it inward. Acting from the arm, as in climbing and crawling, it approximates the lower angle of the scapula to the humerus, and thus assists the great pectoral and latissimus in drawing the body in the direction of the fixed point.

REGION OF THE ARM.

Dissection of the Anterior Brachial Region.—Extend the vertical incision made in the dissection of the shoulder, down the middle of the anterior surface of the arm, about an inch beyond the elbow joint; and here intersect it by another made transversely across the upper part of the forearm. Next dissect back the skin and subcutaneous areolar tissue half way around the limb, so as to expose the brachial fascia or aponeurosis. When the aponeurosis has been studied, it may be removed in the same manner.

The *Brachial Fascia* or *Aponeurosis* is analogous to the femoral aponeurosis; and, although very much less thick, is sufficiently strong to prevent displacement of the muscles during their contraction. It is connected above to the clavicle, acromion, infraspinous fascia and tendons of the latissimus, great teres, and great pectoral muscles, and extends down upon the arm to the elbow, where it is connected to the internal and external condyles of the humerus, and is continuous with the fascia of the forearm. It is perforated at numerous points for the passage of blood-vessels and nerves, and is in contact by its superficial surface with the subcutaneous areolar tissue, superficial veins, and cutaneous nerves. Its deep surface is in contact with the subjacent muscles, and connected to the bone by numerous processes or septa, the two most remarkable of which are attached along the margins of the bicipital groove and the rough lines leading to the two condyles at the lower extremity of the bone; they separate the anterior from the posterior brachial region, and in the lower part of the arm serve as points of origin for muscular fibres. The space included between these two septa is occupied by the biceps and anterior brachial muscles, and the brachial vessels and nerves, and communicates above with the areolar tissue of the axilla. Upon the back of the arm the fascia is very thin.

The **Coraco-brachial Muscle** (Fig. 237, $_{10}$), long and slender, arises by a pointed tendinous extremity, in common with the short head of the biceps, from the summit of the coracoid process of the scapula, passes downward and a little outward, and is inserted near the inner margin of the humerus, a little below its middle.

Use.—To elevate and adduct the arm.

Relations.—The origin of the muscle is between the insertion of the small pectoral and the short head of the biceps, and is intimately blended with the latter for the distance of an inch or more. Its insertion is blended with the process of the brachial fascia that is attached along the inner border of the humerus, and lies between the anterior brachial muscle and inner border of the triceps. The upper extremity of the muscle is covered by the deltoid, and crosses the insertion of the subscapular; its outer border is in contact at first with the short head of the biceps, and lower down with the fleshy belly of this muscle, which slightly overlaps it at its inferior extremity. Its most important relation, however, is with the brachial vessels and nerves which lie along the whole length of its inner border. It is, in fact, the satellite muscle of the brachial artery in the upper half of the arm, and the guide to the surgeon in searching for the vessel in this region for the purpose of applying a ligature. The upper part of the muscle is pierced obliquely by the external cutaneous nerve.

Fig. 237.

Muscles of anterior brachial region; anterior half of deltoid cut away. 1, subscapular muscle; 2, biceps; 3, 6, large teres; 4, 4, anterior brachial; 5, extremity of great pectoral; 7, internal head of triceps; 8, tendinous expansion of biceps; 9, extremity of small pectoral; 10, coraco-brachial; 11, long head of biceps; 12, short head of biceps; 13, coracoid process of scapula.

The **Biceps Flexor Muscle of the Forearm** (Fig. 237, $_{2}$) is long, fusiform, and split at its upper part into two slips or heads. It is situated along the whole length of the anterior aspect of the arm, and forms in the middle and lower third of this region a large rounded fleshy mass, whose outlines are readily distinguished through the skin. The *internal* or *short head* arises tendinous from the coracoid process of the scapula in common with the coraco-brachial muscle, soon becomes fleshy, descends, inclining a little outward, and a little above the middle of the arm joins the long head to form

the fleshy belly. The *external* or *long head* arises by a long narrow rounded tendon from the highest point of the circumference of the glenoid surface of the scapula, and is blended here with the glenoid ligament that surrounds the articular surface. It crosses outward through the upper part of the shoulder joint, and, entering the bicipital groove upon the humerus between the smaller and larger tuberosities, it descends to join the short head. In passing through the shoulder joint, the tendon, although within the capsular ligament, does not properly perforate the joint, the synovial membrane being reflected around it in the form of a tubular sheath, which is prolonged down the bicipital groove as far as the insertion of the tendons of the great pectoral, latissimus, and large teres muscles. In the recent state, the groove is converted into a canal by strong tendinous fibres attached along its two ridges, and continuous with the capsular ligament of the joint and the tendons above mentioned. The large rounded fleshy belly, formed by the union of the two heads, commences about the middle of the arm, descends vertically, and, about an inch above the elbow joint, narrows to a thick flat tendon, which passes in front of the joint. It then turns backward through the triangular space between the round pronator and long supinator muscles of the forearm, glides over the anterior part of the tubercle of the radius, a synovial bursa intervening, and is inserted into the back part of the tubercle. The inner border of this tendon gives off a broad aponeurotic expansion, which passes obliquely downward and inward in front of the elbow joint, superficial to the brachial artery and median nerve, to become continuous with the fascia of the forearm.

Use.—To flex the elbow joint, and also to assist in rotating the forearm from a prone to a supine position. Having forcibly flexed the forearm, it may act in a feeble manner upon the arm, in elevating and adducting it. When the forearm is fixed, as in climbing, it assists in elevating the body. The long head aids the scapular muscles in keeping the head of the humerus in place, and offers a serious obstacle to upward dislocations.

Relations.—The upper part of the muscle is covered by the deltoid and great pectoral muscles, and rests upon the humerus; but in the lower half or two-thirds of its extent, it is covered by the skin and fascia, and separated from the bone by the anterior brachial muscle. The inner border is in contact, in the upper half of the arm, with the coraco-brachial muscle; and in the lower, with the brachial artery, slightly overlapping this vessel.

Dissection.—Divide the two heads of the biceps, and turn it downward and dissect the thin fascia from the surface of the anterior brachial muscle.

The **Anterior Brachial Muscle** (*brachialis anticus*), broad and tolerably thick, arises from the whole breadth of the lower half of the anterior

surface of the humerus, extending upward a short distance upon each side of the insertion of the deltoid. It passes over the anterior surface of the elbow joint, adhering closely to its thin anterior ligament, and is inserted by a short thick tendon into the lower face of the coronoid process of the ulna, and into the rough surface of the bone immediately below.

Use.—To flex the forearm; it is also of great service in holding the ulna in close contact with the humerus, so as to prevent dislocation.

Relations.—Its anterior surface is in contact with the biceps muscle, the external cutaneous nerve crossing between, and with the brachial artery and median nerve, which rest upon it, near the internal border; its posterior surface is in immediate contact with the bone; its external border is closely connected to the fibrous septum, which separates it from the external head of the triceps, long supinator, and radial extensor muscles, the musculo-spiral artery and nerve intervening near the elbow joint; its internal border is in contact above with the insertion of the coracobrachial, and below with the origin of the round pronator muscle of the radius.

Dissection of the Posterior Brachial Region.—The posterior region of the arm contains but one muscle, the triceps, which may be exposed by dissecting off the skin and fascia. For this purpose, the muscle should be made tense by placing a block under the anterior surface of the arm, the point of the scapula being fastened back by hooks, and the forearm allowed to hang flexed over the edge of the table.

The **Triceps Extensor Muscle of the Forearm** occupies the whole length of the posterior surface of the humerus. It is broad and thick in the lower half of its extent, and consists superiorly of three divisions or heads, distinguished as internal, middle, and external, with reference to their position.

The *internal* or *short head* arises from the posterior surface of the humerus, near its inner border, by a pointed extremity, which reaches nearly as high as the insertion of the large teres, and from the intermuscular septum almost as low down as the internal condyle. The *middle* or *long head* arises from the superior third of the axillary border of the scapula and lower part of the circumference of the glenoid cavity, by a flattened tendon, which lies between the large and small teres muscles near their insertion. The *external head* arises from the surface of the humerus, commencing immediately below the greater tuberosity, and extending along the outer border of the bone to the external condyle, and from the intermuscular septum. From these several points, the fibres of the muscle descend; those of the middle vertically, the internal obliquely backward, and the external obliquely inward. They terminate in two large strong tendinous layers, one superficial and the other deep seated, which unite just above the elbow joint, and are inserted into the posterior upper part of the olecranon process of the ulna.

Use.—To extend the forearm; and, when this is accomplished, to assist slightly in carrying the arm backward, which it does through the connection of its long head with the scapula.

Relations.—The long head lies between the great and small teres muscles, is closely connected to the capsular ligament of the shoulder joint, and is the principal obstacle to dislocation of the head of the humerus into the axilla. The deep surface of the muscle is in close contact with the whole extent of the posterior surface of the bone, the musculo-spiral nerve and accompanying artery passing obliquely between the two. The internal and external borders are closely connected to the fibrous septa that separate it from the muscles of the anterior brachial region.

The Vessels and Nerves met with in the dissection of the arm are continuations of the axillary artery, vein, and plexus, and will be hereafter particularly described under the Vessels and Nerves of the Superior Extremity.

REGION OF THE FOREARM.

Dissection of the Anterior Region of the Forearm and Palm of the Hand.—Place the limb in a supine position, and fasten the thumb and fingers to the table by tacks or strong pins driven through the nails. Then divide the skin by an incision extending from midway between the condyles of the humerus to the middle of the wrist; and extend it thence along the middle of the palm of the hand and the palmar surface of the middle finger. Intersect this by two others, one across the wrist and the other along the roots of the fingers; and turn aside the flaps on each side, leaving the fascia upon the surface of the muscles. In the hand, this dissection will be found rather difficult, owing to the close attachment of the skin to the palmar aponeurosis, but should not on this account be neglected, for it is one of no little practical importance. Lastly, dissect the skin from the palmar surface of the thumb and one or two fingers, commencing by an incision made either upon one side of each, or, more conveniently, along the middle.

When the fasciæ of the forearm and hand have been studied, they may be removed in the usual way.

The *Fascia of the Forearm* invests the whole of this division of the upper extremity in one common sheath, which is thicker behind than in front, and increases in thickness from the elbow to the wrist. It is attached above to the condyles of the humerus, tendons of the biceps, anterior brachial and triceps muscles, and to the whole length of the posterior surface of the ulna; and is continuous below with the annular ligaments of the wrist and palmar aponeurosis. It is perforated at various points for the passage of bloodvessels and nerves, but is actually wanting in only one place, the bend of the elbow. Here the deficiency corresponds to the triangular space formed by the round pronator and long supinator muscles, and establishes a communication between the subcutaneous areolar tissue and the sheaths of the muscles of the forearm. The superficial surface of the fascia is connected to the subcutaneous

areolar adipose tissue, and numerous subcutaneous veins and nervous filaments hereafter to be described. Its deep surface is in close contact with the muscles, to each one of which it furnishes a separate sheath, thus rendering their dissection exceedingly tedious.

The *Anterior Annular Ligament of the Wrist* is a broad, thick, fibrous band, stretched across the deep groove upon the anterior surface of the carpus, and attached by one extremity to the pisiform and unciform bones, and by the other to the trapezium and scaphoid. Its office is to confine the flexor tendons of the fingers in their places during contraction. Its superior border is continuous with the fascia of the forearm and with the tendon of the middle flexor muscle of the wrist (palmaris longus); and its inferior with the palmar aponeurosis. Its anterior surface is subcutaneous in the middle line of the wrist, internal to which it gives origin to the muscles of the ball of the thumb, and is crossed near the pisiform by the ulnar artery. Its deep surface is in relation with the flexor tendons and median nerve, and is lined by a reflection of the common synovial bursa that invests these tendons.

The *Posterior Annular Ligament* is a thickened portion of the fascia of the forearm, six or eight lines in width, which passes across the back of the wrist obliquely, and is attached by its internal extremity to the pisiform bone and palmar aponeurosis, and, by its external, to the lower extremity of the radius. Its office is to confine the extensor tendons of the hand, for which it forms a number of tubular sheaths by processes from its under surface. Each one of these sheaths, six in number, is lined by a separate synovial bursa, which extends some distance above the ligament, and accompanies the inclosed tendon down upon the hand, sometimes as far as its insertion.

The *Palmar Aponeurosis* (Fig. 238) covers the deep muscles of the palm of the hand, and the flexor tendons on their way to the fingers; it consists of a middle and two lateral divisions. The middle portion is a very dense, thick, triangular and fibrous lamina, continuous above with the anterior annular ligament of the wrist and tendon of the middle carpal flexor muscle, and inserted into the ligaments of the metacarpo-phalangeal articulations of the four fingers. Its arrangement at the roots of the fingers is worthy of careful observation. Opposite the heads of the metacarpal bones it divides into eight little slips, two for each finger, which, turning round to be inserted into the lateral ligaments of the metacarpo-phalangeal articulations, form four arched margins, beneath which the flexor tendons of the fingers pass in front of the heads of the metacarpal bones. The superficial surface of the aponeurosis is intimately united to the skin by very numerous fibrous prolongations, a variable quantity of firm areolar adipose tissue intervening; its deep surface is in relation with the palmar arterial arch, the median and ulnar nerves and flexor tendons, to which it is connected by loose areolar tissue.

The *Sheaths* or *Thecæ of the Flexor Tendons of the Fingers*, also seen in this dissection, consist of very thick continuous fibrous bands, which are attached along the opposite lateral margins of each phalanx, and convert the grooves upon the anterior surfaces of these bones into as many distinct canals, each one occupied by two tendons. They are lined by loose synovial bursæ, and are indispensably necessary to prevent the tendons starting from the bones during contraction.

Fig. 238.

Muscles of anterior region of forearm. 1, lower part of biceps; 2, part of anterior brachial; 3, edge of triceps; 4, round pronator of radius; 5, radio-carpal flexor; 6, middle carpal flexor (palmaris longus); 7, a division of superficial flexor of fingers; 8, ulno-carpal flexor; 9, palmar aponeurosis; 10, small palmar muscle; 11, abductor of thumb; 12, portion of short flexor of thumb; 13, long supinator; 14, metacarpal and first phalangeal extensors of thumb curving around lower border of forearm.

The Muscles situated upon the Anterior Region of the Forearm are eight in number, and belong respectively to the first group of the first, second, and third class; that is, they are pronators of the forearm, flexors of the wrist, and flexors of the fingers. They nearly all originate by a common muscular and tendinous mass from the inner condyle of the humerus and inner side of the forearm, and are arranged into a superficial and a deep layer. The superficial layer comprises the round pronator, radio-carpal flexor, middle carpal flexor (palmaris longus), ulno-carpal flexor, and superficial flexor of the fingers. The remaining three, forming the deep layer, are the deep flexor of the fingers, long flexor of the thumb, and square pronator. They should be examined in the order in which they are here mentioned, and, in separating them, the student should commence about the upper third of the forearm, for they are so intimately blended at their origin as not to be readily distinguished from one another.

The **Round Pronator Muscle** (*pronator radii teres*, Fig. 238, 4), the most internal* of the superficial layer, is situated obliquely across the front of the upper third of the forearm. It arises, tendinous and fleshy, from the inner condyle of the humerus and intermuscular septa, and, by a thin tendinous expansion, from the coronoid process of the ulna, the median nerve passing between its two heads. It descends outward in the form of a round fleshy belly, and terminates in a flat tendon, which

* The forearm is considered as presenting with the palm of the hand forward, and the terms internal and external have reference to its two borders; the former corresponding to the ulna, and the latter to the radius.

wraps around the anterior surface of the radius about its middle third, and is inserted into a rough surface on the outer side of that bone.

Use.—To rotate the radius, and, at the same time, to carry its lower extremity to the inner side of the ulna, thus turning the hand from a supine to a prone position; it is, besides, a flexor of the elbow joint.

Relations.—The origin and anterior surface of the muscle are superficial; the internal border passes obliquely across the radio-carpal flexor; the external border forms the inner boundary of the triangular space at the bend of the elbow, in which are contained the tendons of the biceps and anterior brachial muscles, the brachial artery and median nerve; the insertion is covered by the long supinator muscle, and crossed by the radial artery, veins, and nerve.

The **Radio-carpal Flexor Muscle** (*flexor carpi radialis*, Fig. 238, 5), long and tapering, arises from the inner condyle of the humerus, and from the fibrous septa that separate it from the preceding muscle and the middle carpal flexor, between which it is placed. It descends outward in the form of a thick fleshy belly, and terminates a little below the middle of the forearm in a flat tendon, which passes beneath the outer extremity of the anterior annular ligament, and through a groove in the trapezium, to be inserted into the upper extremity of the second metacarpal bone.

Use.—To flex the hand at the wrist, and, secondarily, the forearm at the elbow; it also assists in pronation, and abducts the hand.

Relations.—It is crossed obliquely above by the round pronator, below which, as far as the annular ligament, it is subcutaneous; it is situated at first between the pronator and middle carpal flexor, and then between this latter and the long supinator; on the wrist and hand, it is covered by the anterior annular ligament and the muscles of the ball of the thumb. Its most important relation, however, is that with the radial artery, veins, and nerves, which join the outer side of the muscle about the middle of the forearm, and continue along the corresponding side of ts t endon as far as the wrist. The tendon forms, therefore, the guide to the artery in examining the pulse and in the application of the ligature.

The **Middle Carpal Flexor or Long Palmar Muscle** (*palmaris longus*, Fig. 238, 6), long and narrow, arises from the inner condyle of the humerus and fascia of the forearm by a delicate tendon, but soon forms a small fleshy belly, from which a long slender tendon proceeds, to be inserted into the anterior annular ligament and palmar aponeurosis.

Use.—To flex the wrist, and make the palmar aponeurosis tense.

Relations.—By its deep surface, with the superficial flexor of the fingers, internally with the ulno-carpal flexor, and externally with the radio-carpal flexor.

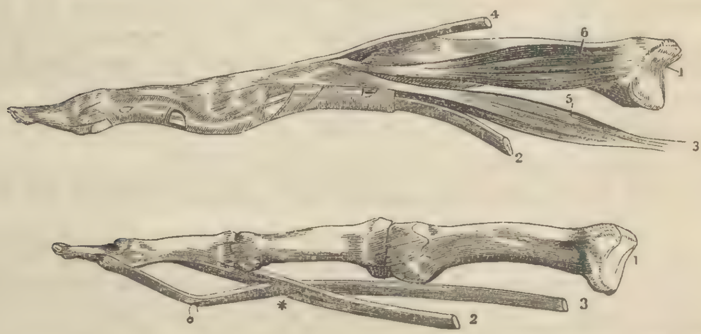
The **Ulno-carpal Flexor Muscle** (*flexor carpi ulnaris*, Fig. 238, 8) is situated more nearly on the inner border of the forearm than upon its anterior surface. It arises from the back part of the inner condyle of the humerus, and from the inner side of the olecranon process, the ulnar nerve separating its two heads. It is also connected, by means of the intermuscular fascia, to the inner edge of the upper two-thirds of the ulna. From these points, the fleshy fibres converge very gradually to a flat tendon, which is inserted into the pisiform bone and base of the fifth metacarpal bone.

Use.—To flex and adduct the hand.

Relations.—It is covered by the fascia and skin, lies upon the deep flexor of the fingers, and is in contact, by its radial border, in the lower two-thirds of the forearm, with the ulnar artery and nerve.

Dissection.—Divide the three flexors of the wrist, and turn back their cut extremities, and the superficial flexor of the fingers will be brought into view.

Fig. 239.



Metacarpal and phalangeal bones of fingers, with tendons. In first figure, tendons of flexor muscles are bound to finger by fibrous sheath; in second, they are freed from that structure, as well as from synovial membrane by which it is lined. 1, metacarpal bone; 2, tendon of superficial flexor muscle perforated at * by 3, tendon of deep flexor; 4, tendon of common extensor muscle; 5, lumbrical muscle; 6, interosseous muscle.

The **Superficial Flexor Muscle of the Fingers** (*flexor digitorum sublimis perforatus*), broad in the middle, pointed above, and divided below into four long tendons, arises from the inner condyle of the humerus, internal lateral ligament, coronoid process of the ulna, and oblique line of the radius. The four tendons commence in the lower third of the forearm, pass beneath the annular ligament, and, having reached the palm of the hand, diverge toward the fingers. At the roots of the fingers each tendon enters its corresponding sheath (theca), in company with and upon the surface of the tendon of the deep flexor, and opposite the first phalanx splits into two lateral slips, which proceed forward upon each side of the tendon of the deep flexor, and, converging upon the deep surface of the latter, are inserted into the forepart of the second phalanx (Fig. 239).

Use.—To flex the second joints of the fingers; then the wrist; and possibly, also, the forearm upon the humerus.

Relations.—It is covered at its origin by the round supinator, radio-carpal flexor, and middle carpal flexor muscles; the last two rest upon its anterior surface as far as the wrist. That portion of the muscle between the middle and ulno-carpal flexors is subcutaneous. It covers the deep flexor muscles, ulnar artery, veins, and nerve, and median nerve. In the hand its tendons are situated beneath the palmar aponeurosis and palmar arterial arch, and covers the deep flexor tendons and lumbrical muscles.

Dissection.—Divide the superficial flexor about the middle of the forearm, and reflect back its cut extremities.

The **Deep Flexor Muscle of the Fingers** (*flexor profundus digitorum perforans*, Fig. 240, $_4$), shorter and smaller than the preceding, arises from the superior three-fourths of the anterior surface of the ulna and the contiguous portion of the interosseous membrane, descends along the inner side of the forearm in the form of a thick fleshy bundle, and terminates in four tendons; these pass beneath the anterior annular ligament, diverge upon the palmar surface of the metacarpus, enter the sheaths upon the fingers, pass between the slips of the superficial flexor tendons, and are inserted into the bases of the last phalanges. The tendon appropriated to the index finger separates higher up than the others, and often appears to belong to a distinct muscle.

Use.—To flex the last joints of the fingers; and, secondarily, the hand upon the forearm.

Relations.—It is covered in the forearm by all the preceding muscles, and by the ulnar vessels and nerves, which descend upon its surface along the ulnar border. Its deep surface rests upon the ulna and interosseous membrane in the upper three-fourths of the forearm, and below upon the anterior surface of the square pronator. Its tendons lie on the inner side of those of the superficial flexor while beneath the annular ligament; but in the hand and upon the fingers are placed directly beneath them. Connected to these tendons is a set of little fleshy slips, called the lumbrical muscles, which will be described in connection with the muscles of the hand.

The **Long Flexor Muscle of the Thumb** (*flexor longus pollicis*, Fig. 240, $_5$), situated along the outer side of the preceding, arises from the upper two-thirds of the anterior surface of the radius, commencing just below the tubercle, and from the adjacent part of the interosseous membrane. The fibres descend obliquely forward to a tendon, which passes beneath the outer extremity of the anterior annular ligament and the muscles of the thenar eminence,* and between the short flexor muscles

* The ball of the thumb is called the thenar, and that of the little finger the hypothenar eminence.

and sesamoid bones of the thumb, and is inserted into the base of the last phalanx.

Use.—To flex the thumb upon the hand, and the hand upon the forearm.

Relations.—In the forearm, it is covered by the superficial flexor of the fingers, radio-carpal flexor, long supinator muscles, and radial vessels, and rests upon the radius, interosseous membrane, and square pronator muscle. Its inner border is separated from the deep flexor of the fingers by the anterior interosseous artery and nerve.

Dissection.—Divide the two preceding muscles, and reflect back their cut extremities, and the square pronator muscle, covered by a thin prolongation of the brachial fascia, will be brought into view.

The **Square Pronator Muscle** (*pronator quadratus*, Fig. 240, $_6$), flat and quadrangular, occupies the whole breadth of the anterior surface of the forearm just above the wrist. It arises by tendinous and fleshy fibres from the lower fifth of the internal and anterior surface of the ulna, passes transversely outward, and is inserted into the lower fourth of the anterior surface and outer border of the radius.

Use.—To turn the lower end of the radius over the ulna, and thus pronate the hand.

Relations.—It is crossed by the tendons of the preceding muscles, and by the ulnar and radial vessels, and lies upon the ulna, radius, and interosseous membrane.

Fig. 240.

Deep muscles of front of forearm. 1, internal lateral ligament; 2, capsular ligament of elbow joint; 3, annular ligament inclosing head of radius; 4, deep flexor of fingers; 5, long flexor of thumb; 6, square pronator; 7, adductor of thumb; 8, 9, interosseous muscles.

Dissection of the Posterior Muscles of the Forearm.—Having completed the dissection of the anterior region of the forearm, the student should turn the limb over, having previously placed a wet cloth upon the palmar surface of the hand to prevent the muscles of this region from becoming dry. To expose the muscles upon the back of the forearm, the skin should be dissected off, and then the fascia, commencing along either the ulnar or radial border. The skin upon the back of the hand and fingers should also be dissected off, to examine the insertions of the extensor tendons.

The Muscles situated upon the Outer and Back Part of the Forearm, twelve in number, are supinators and extensors of the hand and extensors of the fingers. They are divided into a superficial and a deep layer, of which the former comprises the seven succeeding muscles.

The **Long Supinator Muscle** (*supinator longus*, Fig. 241, $_4$), the most superficial of the muscles situated along the radial border of the forearm, has a narrow, fleshy origin of about an inch in extent, from the external condyloid ridge of the humerus, nearly as high as the insertion of the deltoid, and from the intermuscular septa that divide it from the triceps behind and the anterior brachial muscle in front. It descends along the outer anterior part of the elbow and radius, and, at about the middle of the forearm, ends in a flattened tendon which continues in the same direction, to be inserted into the outer surface of the lower extremity of the radius.

Use.—To turn the forearm and hand from a prone to a supine position, and also to assist in flexing the forearm upon the arm.

Relations.—It is placed, at its origin, between the triceps and anterior brachial muscles, and is superficial throughout its whole course, except just above its insertion, where its tendon is crossed obliquely by the extensor tendons of the thumb, and covered by the posterior annular ligament. It rests upon the long carpal extensor above, and in the forearm is placed at first between this muscle and the round pronator, the insertion of which it crosses, and is then external to the tendon of the radio-carpal flexor. Its inner border overlaps the radial vessels and nerve, and, in the lower part of the forearm, forms one of the guides to the radial artery in operations upon this vessel.

The **Long Radio-carpal Extensor Muscle** (*extensor carpi radialis longior* $_5$), situated behind and beneath the preceding, arises by tendinous and fleshy fibres from the lower part of the external condyloid ridge of the humerus, descends along the outer border of the elbow and the corresponding border of the radius, and terminates in the upper third of the forearm in a long flat tendon, which continues along the outer and back part of the radius, traverses a groove on the lower extremity of this bone in company with the tendon of the next muscle, and is inserted into the base of the metacarpal bone of the index finger.

Use.—To extend and abduct the hand, and, when the limb is supine, also to assist in flexing the forearm upon the arm.

Relations.—The fleshy belly of the muscle is covered by that of the preceding muscle, but projects beyond it behind. Its tendon lies upon the surface of the tendon of the following muscle, and is crossed by the extensor tendons of the thumb.

The **Short Radio-carpal Extensor** (*extensor carpi radialis brevior*) is exposed by the removal of the preceding. It arises from the lower back part of the external condyle of the humerus in common with the other extensor muscles, and from the external lateral ligament of the elbow joint, descends upon the posterior surface of the radius in the

form of a short and tolerably thick belly, and terminates about the middle of the forearm in a flat tendon. This continues in the same course, traverses the groove upon the lower extremity of the radius conjointly with the preceding, beneath which it is placed, and is inserted into the base of the metacarpal bone of the middle finger. Its action is similar to that of the last-mentioned muscle.

Fig. 241.

Superficial layer of muscles of posterior region of forearm. 1, lower part of biceps; 2, part of anterior brachial; 3, insertion of triceps into olecranon; 4, long supinator; 5, long radio-carpal extensor; 6, short radio-carpal extensor; 7, tendons of insertion of these two muscles; 8, common extensor of fingers; 9, extensor of little finger; 10, ulno-carpal extensor; 11, anconeus; 12, part of ulno-carpal flexor; 13, extensors of metacarpal and first phalangeal bones of thumb lying together; 14, extensor of second phalanx of thumb—its tendon seen crossing tendons of radio-carpal extensors; 15, posterior annular ligament; tendons of common extensor seen upon back of hand, and their mode of division on backs of fingers.

The **Anconeus Muscle** (Fig. 241, $_{11}$), classed with the triceps extensor, but situated upon the upper back part of the forearm, is small and triangular. It arises by a pointed tendinous extremity from the outer back part of the external condyle of the humerus, passes downward and inward, spreading out as it descends, and is inserted into the outer border of the olecranon process of the ulna.

Use.—To extend the forearm.

Relations.—It is covered above by an expansion from the tendon of the triceps, but is mostly superficial; it is closely applied to the back part of the elbow joint, and covers part of the short supinator muscle.

The **Ulno-carpal Extensor Muscle** (*extensor carpi ulnaris*, Fig. 241, $_{10}$), situated along the inner and back part of the forearm, arises from the back part of the external condyle of the humerus, in common with the other extensor muscles, and for a short distance from the surface of the ulna below the anconeus, descends obliquely inward in the form of a small fleshy belly, and terminates below in a narrow tendon, which proceeds along the back part of the ulna, passes beneath the posterior annular ligament through a groove on the lower extremity of the bone, and is inserted into the base of the metacarpal bone of the little finger.

Use.—To extend and adduct the hand.

Relations.—This muscle is superficial, except where it passes beneath the anterior annular ligament, and covers the short supinator and part of the extensor of the index finger.

The **Common Extensor Muscle of the Fingers** (*extensor communis digitorum*[8]) has a fleshy origin from the external condyle and intermuscular septa, and about the middle of the forearm divides into four fleshy slips, which soon end in as many long slender tendons; these pass beneath the posterior annular ligament, diverge upon the back of the hand, and are connected to each other by tendinous bands. Having reached the roots of the fingers, each tendon spreads out into a strong aponeurosis, which covers the back of the first two phalanges and their respective joints, and, upon a close examination, will be found divided into a middle and two lateral slips, the former inserted into the second phalanx and the latter into the base of the third.

Use.—To extend the fingers and hand.

Relations.—This muscle is covered only by the skin and fascia, and lies upon the short supinator, three extensors of the thumb, extensor of the index finger, posterior interosseous artery and nerve, wrist joint, metacarpal and phalangeal bones and articulations, and dorsal and interosseous muscles. It is situated upon the forearm, between the radio-carpal extensors and the extensor of the little finger.

Dissection.—Divide the common extensor about its middle, and reflect back its cut extremities.

The **Short Supinator Muscle** (*supinator brevis*), short, flat, and triangular, is situated in close contact with the radius in the upper back part of the forearm. It arises from the posterior surface of the external condyle of the humerus, external ligament of the elbow joint, and adjacent part of the outer border of the ulna, wraps closely around the upper part of the radius, and is inserted into the outer and anterior surface of this bone, between its tubercle and the insertion of the round pronator muscle.

Use.—To turn the radius upon its axis, so as to supinate the hand and lower extremity of the forearm.

Relations.—It is covered by the preceding muscles that originate from the external condyle, and is in close contact with the outer side of the elbow joint and upper third of the radius. The posterior branch of the musculo-spiral or radial nerve passes through its fibres.

The **Extensor Muscle of the Little Finger** (*extensor minimi digiti* vel *auricularis*), long and slender, arises in common with the common extensor of the fingers, behind which and the ulno-carpal extensor it descends obliquely inward in the form of a small fleshy belly; it terminates in a long, delicate tendon, which traverses a groove on the lower extremity of the radius beneath the posterior annular ligament, and unites with the fourth tendon of the common extensor to be inserted into the phalanges of the little finger.

Use.—To extend the little finger, acting either with the common extensor, or independently of it.

The **Extensor Muscle of the Index Finger** (*extensor indicis*) arises fleshy from the middle of the posterior surface of the ulna and interosseous membrane, descends outward, and terminates just above the wrist in a slender tendon, which passes beneath the posterior annular ligament, in company with the first tendon of the common extensor, with which it unites to be inserted into the back of the second and third phalanges of the index finger.

Use.—To extend the index finger, acting either conjointly with the common extensor, or independently of it, as in pointing.

The Thumb is provided with three separate Extensor Muscles, which are inserted respectively into the metacarpal bone and first and second phalanges. They are all long and slender.

The **Extensor of the Metacarpal Bone of the Thumb** (*extensor ossis metacarpi pollicis*) arises from the middle back part of the ulna, interosseous membrane, and middle posterior part of the radius, and descends outward and forward in the form of a small rounded fleshy belly. It terminates in a delicate tendon, which passes beneath the posterior annular ligament, traverses a groove on the lower extremity of the radius, continues along the outer border of the wrist, where it also occupies a groove in the trapezium, and is inserted into the base of the metacarpal bone of the thumb.

Use.—To extend the metacarpal bone of the thumb, and also to abduct it; secondarily it extends and abducts the hand.

Relations.—Its fleshy belly is covered by the common extensor of the fingers and ulnar extensor of the wrist, and lies upon the bones and interosseous membrane; its tendon is mostly subcutaneous, and crosses obliquely the two radial extensors of the wrist.

The **Extensor of the First Phalanx of the Thumb** (*extensor primi internodii pollicis*) lies along the ulnar side of the preceding, and like it arises from the ulna, interosseous membrane and radius. Its long narrow tendon occupies the same groove in the radius, and is inserted into the base of the first phalanx of the thumb.

Use.—To extend the thumb at the metacarpo-phalangeal articulation.

The **Extensor of the Second Phalanx of the Thumb** (*extensor secundi internodii pollicis*) is larger than the preceding, and slightly overlaps it. It arises fleshy from the posterior surface of the ulna above the origin of the extensor of the index finger, and ends in a delicate tendon, which

crosses obliquely the lower extremity of the radius in a distinct groove, and passes along the outer side of the wrist and the ulnar side of the metacarpal bone and first phalanx of the thumb, to be inserted into the base of the second phalanx.

Use.—To extend the thumb at its phalangeal articulation. Upon the outer border of the wrist, the tendon of this muscle is separated from those of the two preceding by a triangular interval forming a depression in the skin when the thumb is extended, in which the continuation of the radial artery may be felt pulsating.

REGION OF THE HAND.

The Muscles of the Hand are all situated upon its palmar surface and between the metacarpal bones. Considered with reference to their relative position, they form three groups, namely, those of the thumb, constituting the thenar eminence or ball of the thumb; those of the little finger, forming the hypothenar eminence; and those occupying the middle of the palm.

The skin and palmar aponeurosis having been removed in the dissection of the forearm, the muscles of the thenar and hypothenar eminences will first claim attention.

The Muscles of the Ball of the Thumb are four in number, namely, the abductor, short flexor, adductor, and opponens.

The **Abductor of the Thumb** (*abductor pollicis*), the most superficial muscle of the thenar eminence, is flat and narrow; it arises fleshy and tendinous from the superficial surface of the anterior annular ligament and from the trapezium, passes outward and forward, and is inserted by a narrow tendinous extremity into the outside of the base of the first phalanx.

Use.—To separate the thumb from the fingers.

Dissection.—Detach the abductor from its origin, and turn it outward.

The **Opponens**, flat and triangular, arises from the anterior annular ligament and trapezium, and is inserted into the whole length of the radial border of the metacarpal bone of the thumb.

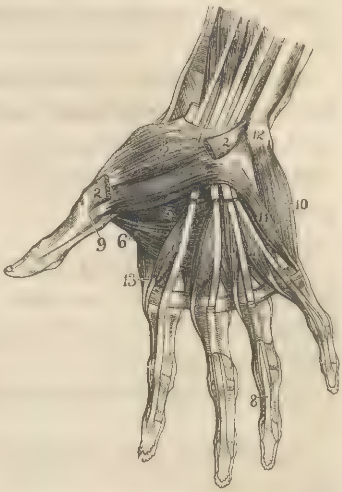
Use.—To approximate the metacarpal bone of the thumb to the palm of the hand.

Dissection.—Detach the opponens from its origin, and turn it outward; in doing this, it will be found to be very intimately connected by its under surface to the following muscle.

The **Short Flexor of the Thumb** (*flexor brevis pollicis*) is larger than the preceding, and placed beneath it. It consists of two parts, which contain between them the tendon of the long flexor. The anterior division arises from the annular ligament and from the trapezium and scaphoid bones, and is inserted tendinous into the base of the first phalanx on its radial side. The posterior division arises from the magnum, trapezoid, and base of the middle metacarpal bone, and is inserted by a short tendon into the base of the first phalanx. The two divisions are at first entirely separate, but unite to form a single fleshy mass, and again divide at their insertion. Two sesamoid bones are found in the tendons, where they pass over the metacarpo-phalangeal articulation.

Use.—To flex the first phalanx upon the metacarpal bone, and the latter upon the wrist.

Fig. 242.



Muscles of palmar surface of hand. 1, anterior annular ligament; 2, origin and insertion of abductor of thumb, its belly removed to expose 3, metacarpal flexor; 4, 5, two bellies of short flexor; 6, adductor of thumb; 7, lumbrical muscles; 8, tendons of deep flexor of fingers passing through slits of superficial tendons; 9, tendon of long flexor of thumb passing from between bellies of short flexor; 10, abductor of little finger; 11, short flexor of little finger, with edge of adductor seen beneath; 12, pisiform bone; 13, first interosseous muscle.

The **Adductor of the Thumb** (*adductor pollicis*), broad, flat, and triangular, arises from about two-thirds of the palmar surface of the middle metacarpal bone, passes outward, its fibres converging, and is inserted by a pointed extremity into the base of the first phalanx of the thumb in connection with the preceding.

Use.—To approximate the thumb to the fingers.

The Muscles of the Little Finger are three in number, namely, the abductor, short flexor, and adductor. Lying upon the surface of these is a cutaneous muscle called the small palmar, which, however, is often so poorly developed as to escape notice.

The **Small Palmar Muscle** (*palmaris brevis*) is a thin quadrangular plane of pale muscular fibres situated immediately beneath the skin of the hypothenar eminence. It arises from the annular ligament and palmar aponeurosis, passes transversely outward, and is inserted into the skin upon the inner border of the hand.

Use.—To draw the skin of the hypothenar eminence toward the middle of the palm, as in forming the hand into a cup.

The **Abductor of the Little Finger** (*abductor minimi digiti*), flat and narrow, arises fleshy from the internal extremity of the anterior annular ligament and from the pisiform bone, passes downward along the inner border of the hand, and is inserted by a short tendon into the base of the first phalanx of the little finger upon its ulnar side.

Use.—To separate the little finger from the others.

The **Short Flexor of the Little Finger** (*flexor brevis minimi digiti*) is situated along the radial side of the preceding, and separated from it by the deep palmar branch of the ulnar nerve. It arises from the annular ligament and the unciform bone, and is inserted into the base of the first phalanx.

The **Adductor of the Little Finger**, more deeply seated than the preceding, and slightly overlapped by it, arises from the annular ligament and unciform bone, and is inserted into nearly the whole length of the fifth metacarpal bone.

Use.—To approximate the little finger to the others.

The Muscles of the Middle Region of the Hand are the lumbrical and interosseous.

The **Lumbrical Muscles**, four in number, are small, round, fleshy fasciculi, which arise near the wrist from the four tendons of the deep flexor muscle of the fingers, proceed downward along with these tendons, and end in as many delicate tendons, which pass to the radial sides of the respective fingers, and, uniting with the tendons of the interosseous muscles, are inserted into the expansion of the extensor tendons upon the back of the first phalanges.

Use.—To assist the flexor tendons in bending the metacarpo-phalangeal articulations.

Dissection.—Remove all the preceding muscles and the flexor tendons from the palm of the hand, and the extensor tendons upon the dorsal surface and the interosseous muscles will be brought into view.

The **Interosseous Muscles**, seven in number, excluding the adductor of the thumb and including the abductor of the index finger, are situated between the metacarpal bones, and are all adductors and abductors of the fingers in reference to the middle line of the hand. They are divided into a palmar and a dorsal group.

The *palmar interosseous*, three in number, are adductors, and belong respectively to the index, ring, and little fingers. Each one originates from the whole length of the corresponding metacarpal bone, and is inserted into the base of the first phalanx.

The *dorsal interosseous* are abductors, and belong to the index, middle, and ring fingers, the middle finger having two, one upon each side. The first dorsal interosseous or abductor of the index finger is the largest of the series, and is sometimes described separately. It is triangular, and has two origins, one from the inner border of the metacarpal bone of the thumb, and the other from the metacarpal bone of the index finger; the fibres converge toward a tendon which is inserted into the base of the first phalanx on its radial side.

VESSELS AND NERVES OF THE SUPERIOR EXTREMITY.

One limb having been reserved for the special study of the vessels and nerves, the student should first direct his attention to the superficial veins and cutaneous nerves.

Dissection.—Divide the skin and subcutaneous areolar adipose layer, which latter is generally very thick in females and children, by an incision extending from the top of the shoulder to the bend of the elbow, and thence along the middle of the anterior surface to the forearm of the wrist; intersect this at each extremity by a circular cut extending entirely around the limb, and proceed to dissect back the two flaps. In performing this dissection, great care is necessary to avoid removing the subcutaneous veins and nerves. If the veins have been previously filled with solid injection, the dissection will be very much facilitated.

The Superficial Veins of the Superior Extremity are situated between the subcutaneous layer of adipose tissue and the aponeurosis that covers the muscles. They commence upon the fingers and hand by an infinite number of small ramified branches, which unite upon the anterior aspect of the forearm to form three main trunks, called the superficial radial, median, and superficial ulnar veins. These terminate at the bend of the elbow in two trunks, named the basilic and cephalic, which proceed up the arm; the former along its inner, and the latter along its outer aspect, and finally end in the axillary vein, but the most common arrangement is as follows; the varieties of these vessels are too numerous to mention.

The **Radial Cutaneous Vein** (Fig. 243), situated, as its name indicates, along the radial or external border of the forearm, commences near the wrist by the union of branches from the dorsal surface of the thumb and forefinger. At the bend of the elbow, it unites with the external division of the median vein, called the median cephalic, to form the cephalic vein. Below the elbow, it is in close relation with branches of the external cutaneous nerve, and, opposite the joint, lies near the trunk of the same.

The **Cephalic Vein**, formed, as just mentioned, by the union of the radial and median cephalic veins at the outer side of the bend of the elbow,

proceeds toward the shoulder, lying at first upon the external border of the biceps muscle, and then in the groove between the deltoid and great pectoral muscles as far as the clavicle, beneath which it bends to join the axillary vein. At its commencement, opposite the elbow, this vessel is in relation with the trunk of the external cutaneous nerve, which here perforates the brachial aponeurosis to reach the skin of the forearm.

Fig. 243.

Superficial veins and nerves at bend of left elbow. 1, internal cutaneous nerve; 2, basilic vein; 3, median basilic vein; 4, deep median vein; 5, posterior ulnar vein; 6, anterior ulnar vein; 7, cephalic vein; 8, external cutaneous nerve; 9, median cephalic vein; 10, radial vein; 11, median vein.

The **Ulnar Cutaneous Veins**, two in number, an anterior and a posterior, are situated along the internal border of the forearm. The posterior commences upon the back of the hand, ascends upon the posterior aspect of the forearm, and at the bend of the elbow comes forward to join the basilic vein. The anterior commences in the neighborhood of the wrist, proceeds upward upon the anterior surface of the forearm near its inner or ulnar border, and, having reached the inner part of the bend of the elbow, unites with a branch from the median, called the median basilic, to form the basilic vein.

The **Basilic Vein** (Fig. 243), formed by the union of the anterior ulnar and median basilic veins, ascends upon the inner side of the biceps muscle, and a short distance above the elbow, varying from half an inch to two or three inches, perforates the brachial aponeurosis, and terminates in one of the accompanying veins of the brachial artery. At other times, it remains distinct and opens into the axillary vein.

The **Median Vein**, situated along the middle of the anterior surface of the forearm, commences by the union of a great number of branches in this region, ascends, and, a short distance below the elbow, is joined by the deep median, which here perforates the fascia: it then divides into two trunks, which open respectively into the cephalic and basilic veins, and are hence called the median cephalic and median basilic veins.

The **Median Basilic Vein**, generally the larger of the two, passes obliquely upward and inward, resting upon the aponeurotic expansion of the biceps tendon, which separates it from the brachial artery. It is crossed also by small branches of the internal cutaneous nerve, but its most important relation is that with the artery, and should be distinctly

borne in mind when it is necessary to bleed from this vein, as it has been not unfrequently wounded in this operation. Sometimes the artery lies superficial to the tendinous expansion, and therefore in immediate contact with the vein, in which case if the latter be transfixed the lancet is almost sure to enter the former.

The **Median Cephalic Vein** ascends outward to join the cephalic vein, crossing in its course branches of the external cutaneous nerve.

The Nerves met with in dissecting the superficial veins of the arm are branches of the internal and external cutaneous. The deep nerves of the superior extremity will be described after the vessels have been dissected.

The **Internal Cutaneous Nerve**, the smallest of the divisions of the brachial plexus, descends the arm along the inner side of the biceps muscle, and, having arrived just above the internal condyle of the humerus, perforates the brachial aponeurosis in company with the basilic vein, and divides into two sets of branches; one of these passes downward and outward, generally behind, but sometimes in front of, the median basilic vein, and is distributed to the skin of the forearm and hand; the other turns round the back of the arm above the elbow, and descends along the ulna to the skin of the back of the forearm and hand. The filaments that lie in relation with the median basilic vein are liable to be wounded by the lancet in opening this vessel.

The **External Cutaneous Nerve**, also a branch of the brachial or axillary plexus, descends outward from its origin, perforates the coraco-brachial muscle, passes between the biceps and anterior brachial muscle, and emerges from beneath the brachial aponeurosis opposite the tendon of the biceps; having reached the surface of the aponeurosis, it descends, sometimes in front of, but generally behind, the median cephalic vein, proceeds along the external side of the median vein, and divides into an anterior and a posterior branch. The former is distributed to the skin of the back of the forearm as far as the wrist, and the latter to the skin upon the anterior surface of the forearm, some of its filaments extending into the hand.

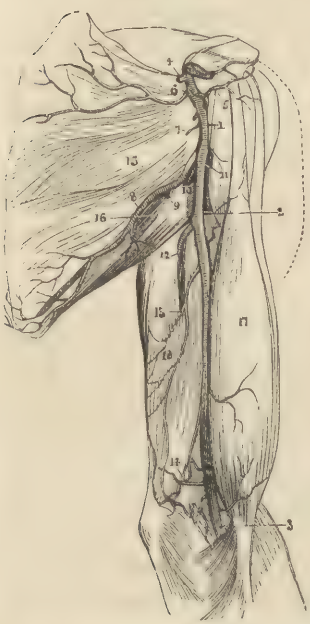
The Superficial **Lymphatics** of the upper extremity are very numerous, and accompany the superficial veins. At the bend of the elbow, some of them pass through a single lymphatic gland situated in front of the internal condyle of the humerus, and terminate in the lymphatic glands placed along the course of the brachial artery; others ascend along with the cephalic vein, and, passing with this vessel between the deltoid and great pectoral muscles, terminate beneath the clavicle in one or more lymphatic glands connected with those in the lower part of the neck.

Dissection.—Having completed the study of the cutaneous veins and nerves, the student should remove the aponeurosis of the arm, forearm, and hand, and trace the brachial artery, veins, and nerves, to their smaller subdivisions. To do this, he should commence in the axilla, and, taking the artery and nerves separately, follow them down the arm and forearm, dissecting off the areolar tissue by which they are surrounded, and separating the muscles as occasion may require.

The Arteries of the Superior Extremity are the brachial or humeral, and its branches.

The Brachial or Humeral Artery.—The Brachial Artery, the continuation of the subclavian and axillary, extends from the lower border of the axillary space to the bend of the elbow, immediately below which it divides into the radial and ulnar arteries. Its course, although nearly straight, is not exactly parallel with the humerus, but crosses this bone very obliquely from above downward and forward. It is covered anteriorly by the skin, subcutaneous areolar adipose tissue, and brachial aponeurosis. In the upper half of the arm it is situated between the internal intermuscular septum of the brachial aponeurosis and the internal surface of the coraco-brachial muscle; in the middle of the arm it lies along the inner side of the biceps, and upon the insertion of the coraco-brachial muscle; thence to the elbow occupies a triangular canal, bounded externally by the inner border of the biceps which slightly overlaps it, internally by the intermuscular septum, which is attached to the condyloid ridge of the humerus, and separates the vessel from the inner border of the triceps, and behind by the anterior brachial muscle, which separates it from the bone.

Fig. 244.



Axillary and brachial arteries. 1, axillary artery, which ends at 2 in brachial; 2 to 3, brachial artery; 4, 5, 6, 7, external thoracic arteries; 8, subscapular artery; 9, its dorsal branch; 10, posterior, 11, anterior circumflex; 12, superior, 13, inferior profunda; 14, anastomotic artery; 15, subscapular muscle; 16, large teres muscle; 17, biceps muscle; 18, triceps.

The brachial artery is accompanied in its whole course by two companion veins, which are closely connected to it on each side, and by the median nerve, which lies immediately in front of it, in the upper part of the arm, but crosses very obliquely near the middle to the inner side.* In the lower part of the arm

* The nerve sometimes crosses behind the artery, instead of in front.

it is also in relation with the basilic vein, which is placed either immediately in front of it or a little to its inner side.

At the bend of the elbow the brachial artery with its companion veins, and the median nerve in close contact with its inner side, is situated beneath the tendinous expansion of the biceps muscle, which separates it from the median basilic vein. The muscles that originate from the internal condyle of the humerus are on the one side, and the round tendon of the biceps on the other, and the lower extremity of the anterior brachial muscle is behind. It then sinks into the triangular space bounded internally by the round pronator muscle, and externally by the long supinator, and divides, about an inch below the articulation, into its two terminal branches.

Occasionally the artery has been observed to deviate from its usual course; instead of occupying the middle line at the bend of the elbow, it is placed in front of the internal condyle of the humerus, whence it passes obliquely outward through the round pronator muscle, to reach the middle of the upper part of the forearm, where it divides into the radial and ulnar arteries. But by far the most common anomaly is a high division of the vessel into its two terminal branches (the radial and ulnar), which may take place at any point between the elbow and axilla. The two vessels thus given off usually descend close together, occupying the ordinary position of the brachial artery, but not unfrequently one or the other pursues a different course. Thus the radial artery, the smaller of the two, often arises from the inner side of the brachial, descends along the corresponding side of the ulnar, and at the bend of the elbow crosses the latter beneath the tendinous expansion of the biceps to reach the external border of the forearm. In other instances, the ulnar division leaves the radial in the lower part of the arm, and passes toward the internal condyle, lying generally beneath the aponeurosis, but sometimes upon its surface.

Branches.—The branches of the brachial artery that have received names are the superior profunda, nutritious, inferior profunda, and anastomotic arteries. Besides these, a number of others are given off to the coraco-brachial, biceps, and anterior brachial muscles.

The **Superior Profunda Artery** arises from the brachial just below the border of the large teres muscle, descends backward between the internal and middle heads of the triceps muscle, and winds spirally around the humerus in company with the musculo-spiral nerve to reach the structures in the neighborhood of the external condyle. It is distributed principally to the triceps and the muscles that originate from the external condyle. Occasionally, this vessel is a branch of the subscapular artery and sometimes of the axillary.

The **Nutritious Artery** is a small twig that comes off about the middle of the arm, enters the nutritious foramen of the humerus, and is distributed to the medullary membrane or endosteum.

The **Inferior Profunda Artery**, larger than the preceding, immediately below which it originates, descends inward in company with the ulnar nerve, and is distributed to the structures about the inner condyle of the humerus, anastomosing with the recurrent branch of the ulnar. It is not unfrequently a branch of the superior profunda.

Fig. 245.

Arteries of forearm. 1, brachial artery; 2, division into radial and ulnar arteries; 3, anastomotic artery; 4, radial artery; 5, ulnar artery; 6, recurrent ulnar; 7, interosseous; 8, anterior carpal; 9, superficial volar; 10, anterior carpal branch of ulnar; 11, superficial palmar arch; 12, principal artery of thumb; 13, radial index artery; 14, digital arteries; 15, recurrent branches.

The **Anastomotic Artery** originates from the brachial an inch or two above the elbow joint. It curves transversely inward across the surface of the anterior brachial muscle, sends branches to the round pronator and triceps muscles, and anastomoses in front with the anterior ulnar recurrent, and, upon the posterior surface of the lower extremity of the humerus, with the posterior ulnar recurrent and superior profunda.

The **Ulnar Artery**, the larger of the two divisions of the brachial, commences about an inch below the elbow joint, descends inclining a little inward, and reaches the anterior surface of the ulna above the middle of the forearm. It then descends vertically to the wrist, where it crosses the internal extremity of the anterior annular ligament, and curves transversely outward across the palm of the hand, to unite with a branch of the radial in the formation of the superficial palmar arch. In the first part of its course, it is covered by the following muscles, which originate from the internal condyle of the humerus, namely, the round pronator, radio-carpal flexor, middle carpal flexor, and superficial flexor of the fingers, and rests upon the insertion of the anterior brachial and the deep flexor of the fingers. At the point where it becomes vertical, about the junction of the upper with the middle third of the forearm, it is joined from within by the ulnar nerve, and the two, together with the two accompanying veins,

descend along the radial border of the ulno-carpal flexor tendon and upon the inner margin of the superficial flexor of the fingers, covered only by the skin, subcutaneous areolar tissue, and the common aponeurosis. In the middle third of the forearm, it lies upon the deep flexor of the fingers, and, in the lower third, upon the square pronator. At the wrist, it is also subcutaneous, and rests upon the internal extremity of the anterior annular ligament.

Branches.—The named branches of the ulnar artery are the anterior and posterior recurrent, interosseous, anterior and posterior carpal and communicating. Besides these, a number of others are supplied to the muscles with which it is in contact.

The *Anterior Ulnar Recurrent Artery*, very small, arises from the ulnar immediately below its commencement, ascends upon the insertion of the anterior brachial muscle covered by the round pronator, to which it gives branches, and anastomoses with the inferior profunda and anastomotic branch of the brachial.

The *Posterior Ulnar Recurrent Artery* is larger than the preceding, and originates immediately below it. It passes upward and inward beneath the superficial muscles that arise from the internal condyle of the humerus, and then between the two heads of the ulno-carpal flexor, lying here beneath the ulnar nerve, supplies branches to the various muscles with which it is in contact, also to the elbow joint and ulnar nerve, and anastomoses upon the olecranon process of the ulna with the anastomotic and superior profunda.

The *Common Interosseous Artery* is a short and tolerably large trunk, which comes from the ulnar artery opposite the bicipital tuberosity of the radius, and divides into an anterior and a posterior branch.

The *Anterior Interosseous Artery* descends the forearm upon the anterior surface of the interosseous membrane and between the deep flexor of the fingers and the long flexor of the thumb. Having arrived at the superior border of the square pronator muscle, it perforates the membrane, and is distributed to the back of the wrist, anastomosing here with the carpal branches of the radial and ulnar.

The *Posterior Interosseous Artery* passes through the deficiency in the interosseous membrane immediately below the elbow joint, and is distributed to the muscles upon the back of the forearm ; it sends a small recurrent branch to the structures upon the back part of the elbow.

The *Anterior and Posterior Carpal Branches* are very small, and supply the corresponding parts of the wrist joint, anastomosing with the carpal branches of the radial artery.

The *Communicating Artery* is given off from the ulnar immediately beyond the pisiform bone, turns down between the short flexor and abductor of the little finger, and joins the deep palmar arch.

The **Superficial Palmar Arch** is the continuation of the ulnar artery in the hand. It commences near the internal extremity of the anterior annular ligament, and is covered here only by the skin, subcutaneous areolar tissue, and small palmar muscle; it crosses the palm of the hand beneath the palmar aponeurosis and upon the superficial flexor tendons, describing a curve convex toward the fingers, and terminates by uniting with the superficial volar branch of the radial upon the ball of the thumb. In crossing the hand, it is superficial to the divisions of the ulnar and median nerves, and gives off numerous branches, called the digital arteries, to the fingers.

The *Digital Arteries*, generally four in number, are given off from the convexity of the palmar arch, and proceed toward the roots of the fingers. The first or most internal runs along the internal or ulnar border of the little finger; the second divides opposite the fourth metacarpal space into two branches which supply the adjacent borders of the little and ring fingers; the third and fourth divide in the same manner opposite the second and third metacarpal spaces, and supply the adjacent borders of the ring and middle and of the middle and index fingers.

Fig. 246.

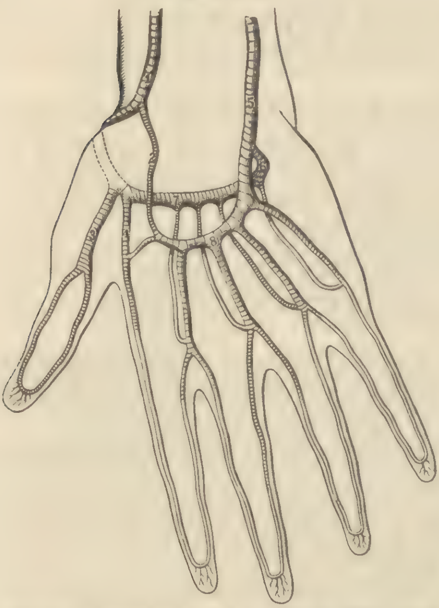


Diagram of superficial and deep palmar arches. 1, radial artery; 2, superficial volar; 3, large artery of thumb; 4, radial index; 5, ulnar artery; 6, communicating artery; 7, deep palmar arch and interosseous branches; 8, superficial palmar arch and digital branches.

The **Radial Artery**, smaller, straighter, and more superficial than the ulnar, descends at first a little obliquely outward to reach the anterior surface of the radius, along the front of which it then proceeds in a vertical direction; having gained the lower extremity of the radius, it turns round the outer border of the wrist, passes through the angle formed by the metacarpal bones of the thumb and index finger, and crosses the deep part of the palm of the hand to form the deep palmar arch, which is completed by uniting with the communicating branch of the ulnar artery. In the first part of its course, the artery is in contact with the tendon of the biceps, rests upon the short supinator

muscle, and is overlapped by the fleshy part of the long supinator. About the middle of the forearm it becomes subcutaneous, and lies upon the insertion of the round pronator muscle and between the long supinator and radio-carpal flexor. In the lower part of the forearm, the point at which the pulse is usually examined, it lies almost immediately upon the bone, between the tendons of the radio-carpal flexor and long supinator muscles, and is covered only by the common aponeurosis, subcutaneous areolar tissue, and skin.

The radial artery is accompanied by two veins, which are in close connection with it on each side. At the junction of the superior with the middle third of the forearm, it is joined from without by the musculo-spiral or radial nerve, which, however, leaves it before reaching the wrist, and turns round the radius to the back of the limb.

At the lower extremity of the radius, the artery turns outward below the styloid process, passes beneath the tendons of the first two extensors of the thumb, traverses the triangular space between their tendons and the tendon of the extensor of the first phalanx, and may be here felt pulsating, being covered only by the skin and fascia; it next crosses beneath the last-named tendon, and enters the palm of the hand through the angle formed by the metacarpal bones of the thumb and index finger, and between the heads of the first interosseous muscle.

Branches.—The branches of the radial artery are numerous and mostly small. Those given off while the vessel is upon the forearm are the radial recurrent, muscular, anterior carpal and superficial volar.

The *Radial Recurrent Artery* arises just below the elbow joint, ascends to the parts about the external condyle, and anastomoses with the superior profunda.

The *Muscular Branches* are small twigs to the muscles upon the anterior and outer part of the forearm.

The *Anterior Carpal* is a small branch given off opposite the lower extremity of the radius; it ramifies upon the front of the wrist, and anastomoses with the corresponding branch of the ulnar.

The *Superficial Volar*, generally small, but not unfrequently quite large, arises from the radial immediately below the inferior extremity of the radius, passes downward and inward over the external attachment of the anterior annular ligament, sends branches to the muscles of the thenar eminence, and terminates in the outer extremity of the superficial palmar arch.*

The branches given off by the radial while upon the wrist are the posterior carpal, metacarpal, dorsal arteries of the thumb, and dorsal artery of the index finger.

The *Posterior Carpal Artery* passes across the back of the wrist

* The communication between the superficial volar and the superficial palmar arch is often wanting.

beneath the radial extensor tendons, anastomoses with the terminal divisions of the anterior interosseous artery, and gives off *dorsal interosseous* twigs to the muscles of the third and fourth metacarpal interspaces.

The *Metacarpal Branch* descends between the second and third metacarpal bones, and sends twigs to the backs of the index and middle fingers.

The *Dorsal Arteries of the Thumb*, two in number, and very small, come off upon the back of the metacarpal bone, and are distributed to the skin of the back of the thumb.

The *Dorsal Artery of the Index Finger*, also very small, runs along the radial side of the back of the index finger.

The branches of the radial in the palm of the hand are the large artery of the thumb, and the radial branch for the index finger.

The *Large Artery of the Thumb* (magna pollicis) arises from the radial immediately after it reaches the palm of the hand, descends along the ulnar border of the metacarpal bone of the thumb, and opposite the head of this bone divides into two branches, which proceed along the opposite borders of the thumb.

The *Radial Branch for the Index Finger* arises close to the preceding, and descends to supply the radial border of the index finger, the opposite border being supplied by one of the digital branches of the superficial palmar arch.

The **Deep Palmar Arch**, the continuation of the radial artery in the hand, traverses the palmar surface of the metacarpus from without inward, forming a curve convex forward, and joins the communicating branch from the superficial palmar arch. It gives off several small branches, the most important of which are the three interosseous, to the muscles of the three metacarpal interspaces.

The Deep Veins.—All the larger subdivisions of the brachial artery have each two companion veins, one upon each side. The veins are contained within the sheaths of the arteries and are closely adherent; they communicate freely with each other by cross branches, and receive at different points communicating branches from the superficial veins. All eventually terminate in the two brachial veins, which at the margin of the axilla unite to form the axillary vein heretofore described.

The **Deep Lymphatics** of the upper extremity are very numerous, and accompany the larger bloodvessels. Some of them, in their course toward the trunk, pass through the lymphatic glands situated along the brachial artery, before reaching the lymphatic glands of the axilla.

The Nerves of the Upper Extremity are all, with the exception of the humeral branch of the second intercostal nerve, branches of the brachial

or axillary plexus, the structure and relations of which have been described in connection with the anatomy of the neck and axilla. They are, the suprascapular, subscapular, circumflex, internal cutaneous, small internal cutaneous, external cutaneous or musculo-cutaneous, ulnar, median, and musculo-spiral or radial nerves.

The superficial nerves of the upper extremity, branches of the external and internal cutaneous, have been already described (p. 581).

The **Suprascapular Nerve**, the only one of the series that originates above the clavicle, is derived from the fifth cervical nerve. It passes from the root of the neck obliquely outward beneath the anterior border of the trapezius muscle, traverses the suprascapular notch, and is distributed to the supraspinous and infraspinous muscles, furnishing also a small filament to the shoulder joint.

The **Subscapular Nerves**, generally three in number, arise from the middle of the axillary plexus, descend outward and backward, and are distributed respectively to the subscapular, large teres, and latissimus muscles.

The **Circumflex Nerve** arises from the back part of the brachial plexus in common with the musculo-spiral, curves downward and outward beneath the neck of the humerus, in company with the inferior circumflex artery, and is distributed to the outer part of the deltoid muscle and the skin of the upper part of the arm. Before leaving the axilla it sends filaments to the anterior part of the deltoid and skin of the shoulder. Laceration of this nerve is sometimes produced by dislocations of the head of the humerus into the axilla, and is followed by paralysis of the deltoid muscle and consequent inability to elevate the arm.

The **Internal Cutaneous Nerve**, next to the smallest of the divisions of the brachial plexus, arises in common with the ulnar and internal head of the median nerve, descends upon the inner aspect of the arm, at about the middle of which it perforates the brachial aponeurosis, and divides into an internal and an external branch. The internal and smaller division sends twigs to the integuments about the internal condyle of the humerus, and proceeds along the inner border of the forearm in company with the superficial ulnar veins, giving filaments to the skin as far as the wrist. The external divides into a number of branches which pass beneath and sometimes in front of the median basilic vein, and are distributed to the skin upon the middle of the anterior surface of the forearm as low as the wrist.

The **Small Internal Cutaneous Nerve** arises generally in common with the preceding, crosses the axillary vein obliquely behind, descends

upon the inner side of the brachial vessels, communicating with the intercosto-humeral nerve, perforates the brachial aponeurosis about the middle of the arm, and is distributed to the skin of the lower half of the arm on its inner and posterior aspect.

Fig. 247.

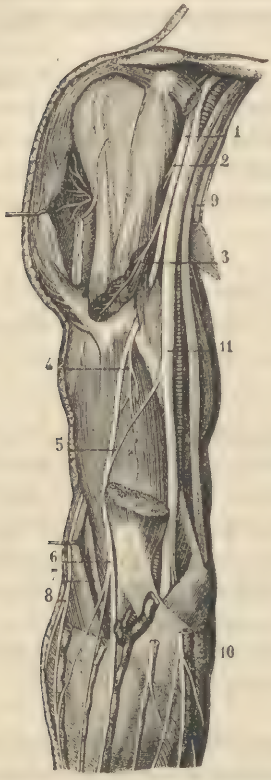
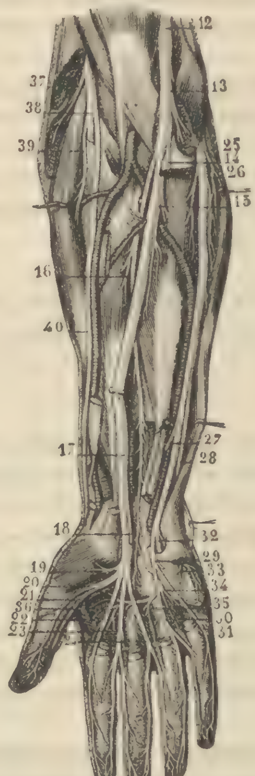


Fig. 248.



External cutaneous, median, ulnar, and musculo-spiral nerves. 1, external cutaneous nerve; 2, 3, 4, muscular branches; 5, anastomotic filament from median; 6, division of external cutaneous nerve into branches to forearm; 7, musculo-spiral nerve; 8, cutaneous branch of latter; 9, internal cutaneous nerve; 10, its branches to forearm; 11, median and ulnar nerves; 12, median nerve; 13–16, muscular branches; 17, anterior interosseous nerve; 18, superficial palmar branch; 19, branch to muscles of ball of thumb; 20–24, digital nerves of thumb, index, middle, and one side of ring finger; 25, ulnar nerve; 26, muscular branches; 27, 28, cutaneous and dorsal branches; 30, 31, digitals to little and ring fingers; 32, deep palmar branch; 33–36, muscular branches from latter; 37, musculo-spiral nerve; 38, its posterior interosseal division; 39, muscular branch of latter; 40, radial nerve.

The **External Cutaneous Nerve** arises in common with the external head of the median, descends outward through the coraco-brachial muscle, and then between the biceps and anterior brachial muscle, and perforates the brachial aponeurosis a little above the outer part of the bend of the elbow. It then descends beneath the median cephalic vein and divides

into two branches, which are distributed to the skin on the outer border of the forearm, one on its anterior, and the other on its posterior aspect, as far as the wrist. Before becoming cutaneous, this nerve sends branches to the coraco-brachial, biceps, and anterior brachial muscles.

The **Ulnar Nerve**, one of the larger branches of the brachial plexus, arises in common with the internal cutaneous and inner head of the median, descends along the inner side of the brachial vessels, and, about the middle of the arm, inclines inward, perforates the internal intermuscular septum, and reaches the interval between the internal condyle of the humerus and olecranon, in company with the inferior profunda artery, resting upon the internal border of the triceps muscle, and covered only by the skin and brachial aponeurosis. At the elbow, the nerve passes between the two heads of the ulnar flexor muscle of the wrist, and thence descends upon the anterior surface of the forearm near its inner border. In the upper half of the forearm it is covered by the last-mentioned muscle, but in the lower half it is subcutaneous, and lies between the radial border of the tendon of the same muscle and the ulnar artery. Having arrived at the wrist, the nerve continues in company with the ulnar artery, and upon the surface of the anterior annular ligament divides into a superficial and deep palmar branch. The former is distributed to the skin of the hypothenar eminence, the inner border of the little finger, and the contiguous borders of the little and ring fingers; and the latter to the small muscles of the little finger and to the interosseous muscles.

Branches.—From the axilla to the elbow the ulnar nerve gives off no branches.

Upon the forearm, it sends filaments to the ulno-carpal flexor, and deep flexor muscle of the fingers, to the elbow and wrist joints, to the skin of the forearm, and a dorsal branch to the hand. The last-mentioned division is the largest and most interesting; it leaves the main trunk about two inches above the wrist, descends obliquely backward beneath the ulno-carpal flexor tendon, passes along the back of the metacarpus, and divides into two branches, one of which is distributed to the inner side of the little finger, and the other to the opposed sides of the little and ring fingers.

In the palm of the hand the ulnar nerve divides into a superficial and a deep branch, which are distributed as before mentioned.

The **Median Nerve**, larger than the preceding, arises from the brachial plexus by two heads, about an inch in length, which converge and unite upon the external side of the axillary artery. It descends in an almost straight direction to the middle of the elbow, in company with the brachial artery and veins, but crosses very obliquely in front of these vessels, about the middle of the arm, to reach their inner side, in which relation it enters

the forearm between the two heads of the round pronator muscle. Below the elbow it proceeds along the middle of the anterior region of the forearm, between the superficial and deep flexor muscles of the fingers, to within a short distance of the wrist, where it is placed between the tendons of the radio-carpal and superficial flexor of the fingers, and is covered only by the common aponeurosis and skin. It then enters the palm of the hand beneath the anterior annular ligament and palmar aponeurosis, resting upon the superficial flexor tendons, and divides into two parts, one of which supplies the sides of the thumb and outer border of the index finger, and the other the contiguous borders of the index, middle, and ring fingers.

Branches.—From the axilla to the elbow the median nerve, like the ulnar, gives off no branches. In the forearm it supplies all the pronator and flexor muscles, except the radio-carpal flexor and part of the deep flexor of the fingers, and sends a single filament to the skin of the palm of the hand. The *anterior interosseous nerve*, the largest of the muscular branches, accompanies the anterior interosseous artery, and is distributed to the long flexor of the thumb, deep flexor of the fingers, and square pronator. The *cutaneous branch* perforates the fascia immediately above the annular ligament, and ends in the skin about the middle of the palm of the hand.

After reaching the palm of the hand, beneath the annular ligament and palmar aponeurosis, the median nerve divides, as before mentioned, into an internal and an external branch. The external division supplies the abductor, opponens, and short flexor muscles of the thumb, and sends branches (digital nerves) to the skin of the thumb and index finger. The internal supplies both sides of the middle finger and the adjacent borders of the index and ring fingers.

The *digital nerves*, derived from the two divisions of the median, are five in number, and are distributed to the sides of the thumb, index, and middle fingers, and the radial side of the ring finger, the ulnar side of the last and the two sides of the little finger being supplied by the digital branches of the ulnar. Having gained the angles between the fingers, these nerves lie immediately under the skin, having emerged from beneath the palmar fascia, whence they proceed, the *first* and *second* to the sides of the thumb, and the *third* to the radial side of the index finger; the *fourth* bifurcates, and supplies the contiguous surfaces of the index and middle fingers, and the *fifth* is distributed in like manner to the adjacent borders of the middle and ring fingers.

The **Musculo-spiral** or **Radial Nerve**, the largest of the branches of the brachial plexus, descends the upper part of the arm behind the axillary and brachial vessels, enters between the internal and middle heads of the triceps muscle, winds in a spiral manner around the back of the

humerus in company with the superior profunda artery, and makes its appearance at the outer part of the arm immediately above the elbow, between the long supinator and anterior brachial muscles. In this relation, it reaches the external condyle of the humerus, gives off here the posterior interosseous nerve, and proceeds down the front of the forearm near its outer side, still covered by the long supinator muscle. In the upper third of the forearm it joins the outer side of the radial artery, and, about three inches above the wrist, turns outward beneath the long supinator muscle, to reach the back of the radius, and divides into two branches, which are distributed to the skin upon the dorsal surface of the thumb and first two fingers.

Branches.—The branches given off from the radial nerve in the arm are muscular and cutaneous. The *muscular* branches are numerous, and supply the triceps, anconeus, long supinator, and long radio-carpal extensor. The *cutaneous* branches are—1, the *internal*, which comes off in the internal and upper part of the arm, and is distributed to the skin on the back of the arm; 2, the *superior external*, which arises in the middle and outer part of the arm, descends along the cephalic vein, and is distributed to the skin of the lower half of the arm on its anterior aspect; 3, the *lower external*, which perforates the brachial aponeurosis upon the outer aspect of the arm near its middle, passes to the forearm over the external condyle of the humerus, and turns round the outer border of the forearm, about midway between the elbow and wrist, to reach its posterior surface; it is distributed to the skin upon the back of the lower half of the arm and upon the back of the forearm.

The *Posterior Interosseous Nerve* is, as regards size, the proper continuation of the main trunk of the musculo-spiral. It arises opposite the external condyle of the humerus, turns outward to the back of the forearm through the fibres of the short supinator muscle, and reaches the posterior surface of the interosseous membrane by passing between the superficial and deep extensor muscles. It then descends in company with the posterior interosseous artery to the wrist, and gives branches to all the supinator and extensor muscles of the wrist and fingers, except the long supinator and long radio-carpal extensor.

Upon the lower back part of the forearm, the radial nerve divides, as before mentioned, into two parts. The *external* division, very small, is distributed to the skin on the radial side of the thumb. The *internal* division reaches the posterior surface of the hand, and divides into four dorsal digital nerves which supply the ulnar side of the thumb, both sides of the index and middle fingers, and the radial side of the ring finger, corresponding thus to the distribution of the digital branches of the median nerve.

THE EYE AND ITS APPENDAGES.

The Globe or Ball of the Eye, the essential part of the visual apparatus, lies within the bony orbit, where it is protected and assisted in the proper performance of its functions by a number of accessory structures. The orbits having been already described in connection with the bones of the face, these appendages of the eye will now be considered.

APPENDAGES OF THE EYE.

The Appendages of the Eye, so called, are the eyebrows, the eyelids, the lachrymal apparatus, and the special muscles by which the organ is moved.

The **Eyebrows** (*superciliæ*) are the two hairy arches situated above the eyes, and immediately over the superciliary prominences of the frontal bone. Their general appearance and their differences in different individuals are too familiar to require description. They are peculiar to man, and their use is said to be to assist in protecting the eye from too much light, and also from dust and perspiration; but the probability is, they are intended partly for ornament and partly to express certain emotions of the mind. For this latter end they are provided with a special muscle, called the corrugator, and are connected also with the occipito-frontal and orbicular muscles.

The **Eyelids** (*palpebræ*) are two movable curtains placed in front of each orbit to protect the eye from injury, and, by their closure, to shut out the light. They are transversely elliptical in shape, but the superior is much the broader, and provided with a special muscle for its elevation, called the elevator of the upper eyelid. They are separated from each other by a transverse slit, called the *palpebral fissure*, at the extremities of which they are joined together at an acute angle. The length of the palpebral fissure varies in different individuals, but is always less than the transverse diameter of the orbit, the union between the external extremities of the lids occurring two or three lines internal to the external margin of the orbit; so that, in the operation for removal of the ball of the eye, it is necessary to prolong the fissure outwardly by an in-

cision. Of the two angles, called the *canthi*, formed by the union of the lids, the *external* is more acute, and lies directly in contact with the ball of the eye; the *internal* is long, narrow and rounded, situated upon a plane somewhat below the other, and occupied by the *lachrymal caruncle.* The free margins of the lids are thick and flat in the greater part of their extent, but at the internal canthus they are rounded off and curved. The point of union between the straight and curved portions is marked upon each lid by a small conical elevation, called the *papilla,* upon whose summit is the minute orifice or *punctum* of the corresponding lachrymal canal. When the lids are closed, their free margins are in accurate contact the whole length between the lachrymal papilla and the external canthus; but, owing to the greater breadth of the superior lid, the line of union is below the transverse axis of the eye, and forms a very slight curve, with its convexity presenting downward and forward.

Each lid is composed of skin, areolar tissue, muscular fibres, fibro-cartilage, sebaceous follicles, and mucous membrane.

The *skin* is very thin and delicate, and continuous at the free edge of the lid with the mucous membrane, the conjunctiva. At the line of union between the two are the short stiff hairs, called the eyelashes, which are longer and more numerous on the upper lid than on the lower, and are entirely wanting on both lids internal to the lachrymal papillæ. The number of these hairs is variable; but, as a general rule, they form but one row on each lid. Their direction is curved, the superior convex below, and the inferior in an opposite direction, and their arrangement is doubtless intended to prevent their interfering with each other when the lids are closed.

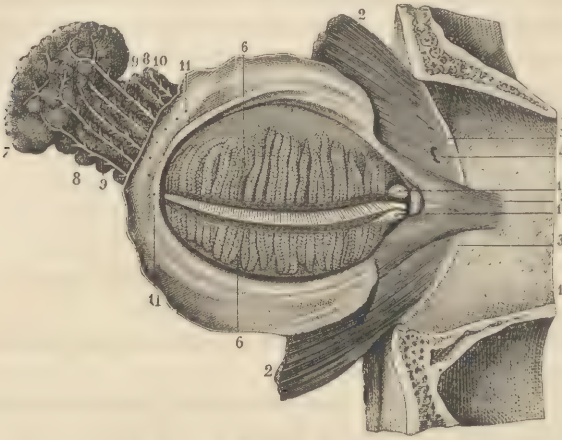
Beneath the skin is a layer of fine, loose *areolar tissue,* which, like that upon the penis, lungs, and some other parts of the body, contains no fat cells, and is hence never the seat of adipose deposit.

Next in order are the pale scattered fibres of the palpebral portion of the *orbicular muscle* (p. 428), and beneath this the tarsal cartilages.

The *tarsal cartilages* are two thin plates of fibro-cartilage, which give elasticity and firmness to the lids, and prevent them from puckering or curling when the orbicular muscle contracts. The superior, the larger of the two, is semi-elliptical; the inferior is in the form of a narrow strip. Their contiguous margins are thick, correspond to the free margins of the lids, and contain the roots of the eyelashes. Their orbital margins are thin, and continued by a fibrous membrane to the periosteum of the corresponding borders of the orbit. The upper edge of the superior cartilage gives attachment also to the expanded tendon of the elevator muscle of the upper lid. The anterior surface of each is covered by the orbicular muscle; the posterior is lined by the palpebral portion of the conjunctiva, and marked by numerous vertical grooves for the accommodation of the Meibomian follicles.

At the internal angle of the eye the tarsal cartilages are connected to the inner border of the orbit by a well-defined fibrous cord, called the *internal palpebral ligament,* and, at the outer angle, to the corresponding border by a less distinct band, named the *external palpebral ligament.*

Fig. 249.



Left eyelid and lachrymal gland, turned forward and inward to exhibit their inner surface. 1, upper and lower part of orbit; 2, portion of palpebral orbicular muscle; 3, attachment of this muscle to inner margin of orbit; 4, perforation for passage of external nasal nerve; 5, offset described as tensor muscle of eyelids; 6, Meibomian follicles; 7, posterior, and 8, anterior portions of lachrymal glands; 9, 10, ducts; 11, orifices opening on inner surface of upper eyelid; 12, 13, lachrymal orifices at summits of lachrymal papillæ.

The *Meibomian follicles* (Fig. 249, $_6$) belong to the class of sebaceous glands; they are imbedded in the posterior surface of the tarsal cartilages external to the palpebral conjunctiva, through which they may be faintly seen as yellow vertical lines of unequal length, and so small as often to escape observation in an ordinary examination. Their number varies from fifteen to twenty on each lid. They consist of minute and slightly tortuous tubes, lined by a scaly epithelium, and terminating in one or more blind extremities. Their orifices may be found, by the aid of a pocket-glass, along the free margins of the lids behind the roots of the eyelashes, where they form a single row from the external canthus to the lachrymal papilla. They secrete a yellow waxy substance, the use of which seems to be to prevent the tears from running over the margins of the lids.

The *lachrymal caruncle* is a small, red, oval body, situated in the inner canthus of the eye. It consists of a group of sebaceous follicles, covered by the mucous membrane, and often has a few short fine hairs growing from its surface.

The **Conjunctiva** (*tunica adnata*) is a mucous membrane, which lines the posterior surface of the eyelids, and covers the anterior surface of the

globe of the eye. It consists, therefore, of a palpebral and an ocular portion. The *palpebral portion* is thick and vascular, closely connected to the internal surface of the tarsal cartilages and Meibomian follicles, and continuous at the free margins of the lids with the skin and with the lining mucous membrane of the Meibomian follicles and lachrymal canals. It is provided with numerous fine papillæ, the enlargement of which in chronic conjunctivitis gives rise to the well-known granular appearance noticed upon this portion of the membrane. The *ocular portion* is thin and transparent, and continuous with the preceding opposite the margins of the orbit, whence it may be traced over the anterior part of the sclerotic coat of the eyeball, to which it is connected by a loose fibro-areolar tissue, called the *ocular fascia.* At the circumference of the cornea, the corium or fibro-vascular layer of the membrane ceases, but the epithelium is continued over the whole of the anterior surface of this structure. At the inner canthus of the eye the conjunctiva forms a slight vertical fold, called, from its shape, the *semilunar fold* (plica semilunaris), which is a rudimentary analogue of the third eyelid (membrana nictitans) of some of the inferior animals.

Although a mucous membrane, the conjunctiva performs the office of a serous membrane, its principal function being to facilitate the movements between the lids and the globe of the eye. Its epithelium belongs to the tessellate variety.

Vessels and Nerves.—The *arteries* of the conjunctiva are derived from the palpebral and lachrymal and from the muscular and anterior ciliary branches of the ophthalmic artery. The *veins* follow the same course as the arteries. The *nerves* are branches of the fifth pair.

The Lachrymal Apparatus consists of—1, the lachrymal gland, which secretes the tears; 2, the lachrymal ducts, by which this fluid is carried off from the conjunctiva; 3, the lachrymal sac, into which it is received; and 4, the nasal duct, by which it is conducted from the latter into the nose.

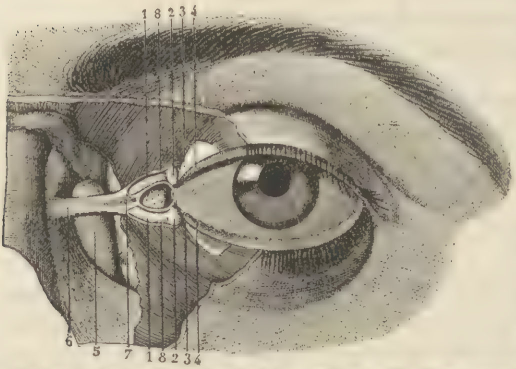
The **Lachrymal Gland** (Fig. 249, $_{7,\ 8}$) is a small semi-ovoidal organ of a pinkish-white color, and about the size of an almond kernel, situated upon the outer and upper surface of the globe of the eye, corresponding to a superficial depression upon the orbital surface of the frontal bone just within the external angular process. It is surrounded by a delicate layer of condensed areolar tissue, and consists of two distinct divisions or lobes of unequal size, the larger of which corresponds to the above-mentioned fossa; the smaller division, called the palpebral lobe, extends down upon the upper back part of the superior eyelid, and is in contact with the conjunctiva. Like other racemose glands, it consists of a number of small lobules held together by areolar tissue and vessels, and is provided with eight or ten very minute excretory ducts, which proceed from the in-

ferior border of the organ to open upon the free surface of the conjunctiva, just where this membrane is reflected from the back of the upper eyelid to the globe of the eye. The office of the lachrymal gland is to secrete the tears, which flow out upon the surface of the conjunctiva and serve to keep this membrane moist.

The artery of the lachrymal gland is a branch of the ophthalmic. Its nervous filaments, which are very few and small, are derived from the first or ophthalmic division of the fifth pair.

The **Lachrymal Canals** (Fig. 250), two in number, and very small, are situated in the margins of the lids at the inner canthus. They each commence by a minute orifice (*punctum*) upon the summit of the corresponding lachrymal papilla, and take at first, for a very short distance, a vertical course, the superior upward and the inferior downward, and at the base of the papillæ turn abruptly inward, and proceed convergingly toward the root of the nose, where they perforate the outer ball of the nasal sac, and open very near each other upon its inner surface. Although their caliber is very small, their walls are very dense and elastic, and lined by a mucous membrane continuous at their orifices or puncta with the conjunctiva. Their direction should be particularly noticed by the student, as it sometimes becomes necessary to introduce a probe through them into the lachrymal sac.

Fig. 250.



Left eye, with portion of eyelids removed, to exhibit lachrymal canals and sac. 1, lachrymal canals; 2, commencement of these at summit of lachrymal papillæ; 3, palpebral cartilages; 4, edges of eyelids; 5, lachrymal sac; 6, internal palpebral ligament; 7, its point of division in front of lachrymal canals; 8, branches of ligament giving attachment to fibres of palpebral orbicular muscle.

Connected with the lachrymal canals is a small muscle called the *tarsal tensor*, or *Horner's muscle*, which may be exposed in the following manner:

Dissection.—Detach the eyelids from the margins of the orbit except at the inner canthus, turn them over the nose, and make them tense by means of a double hook; then dissect the conjunctiva and a subjacent layer of fascia from the posterior face of the inner extremity of each lid, and the muscle will be brought into view.

The **Tarsal Tensor** (*tensor tarsi*) is a small dependency of the orbicular muscle of the eye. It arises from the ridge of the unguiform bone behind the lachrymal groove, passes transversely outward, and divides into two slips,

which are inserted respectively into the superior and inferior lachrymal canals near the puncta. Its use, according to its discoverer, is to dilate the lachrymal sac, and to keep the eyelids applied to the surface of the ball of the eye.

The **Lachrymal Sac** (Fig. 250, $_5$) is the upper, dilated, blind extremity of the nasal duct. It occupies the lachrymal groove formed by the nasal process of the superior maxillary and the lachrymal or unguiform bone at the anterior extremity of the inner wall of the orbit, and is crossed in front and a little above the middle by the tendon of the orbicular muscle. It is about a fifth of an inch in length and breadth, and consists of a strong fibrous envelope, lined by a mucous membrane, continuous through the lachrymal canals with the conjunctiva, and through the nasal duct with the lining membrane of the nose. Its upper extremity is crossed in front by the tendon of the orbicular muscle, which is the guide to the operation for opening the sac, the instrument being introduced immediately below.

The **Nasal Duct** occupies the bony canal leading from the lachrymal groove to the lower meatus of the nose. It is about three-fifths of an inch in length, somewhat narrower at its middle than at either extremity, and descends from above slightly outward and backward. Like the lachrymal sac, it consists of a fibrous and a mucous coat, the former closely adherent to the walls of the bony canal, and the latter continuous above with the lining membrane of the sac and conjunctiva, and below with the mucous membrane of the nose. The lower orifice of the duct is situated close under the anterior extremity of the inferior spongy bone, and is guarded by an imperfect valve formed by a duplication of the pituitary membrane. It is this fold or valve that offers the greatest obstacle to the introduction of an instrument into the canal from below.

MUSCLES OF THE EYE.

Each eye has appropriated to it ten separate muscles, six of which belong to the globe, and the remaining four to the appendages. Three of the latter, namely, the orbicular, corrugator of the eyebrow, and tarsal tensor, have been already described; the remaining one of this set, the elevator of the upper eyelid, and the six proper muscles of the organ, are contained within the orbit, and should now be examined.

Dissection.—Remove the roof and external wall of the orbit by means of two cuts with the saw, meeting behind within a short distance of the optic foramen, taking care to leave a small portion of the roof near the internal angular process of the frontal bone, to show the attachment of the cartilaginous pulley belonging to the superior oblique muscle. This done, proceed with great care to dissect the areolar and adipose tissue from the surface of the muscles and between them.

The **Elevator Muscle of the Upper Eyelid** (*levator palpebræ superioris,* Fig. 251, $_1$), broad in front and narrow behind, arises from the

superior margin of the optic foramen, passes forward and a little upward close beneath the roof of the orbit, gradually expanding, and, having reached the orbital arch, ends in a broad, thin tendon, which curves over the superior surface of the ball of the eye, and is inserted into the whole length of the upper edge of the superior tarsal cartilage.

Use.—To elevate the upper eyelid, drawing it at the same time beneath the orbital arch.

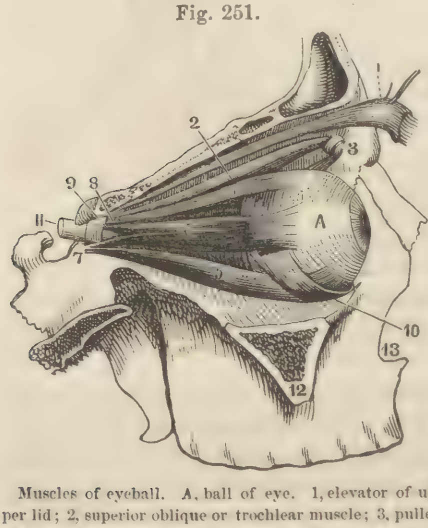
Relations.—The superior surface of the muscle is in contact with the roof of the orbit, and is crossed obliquely behind by the ophthalmic nerve; its inferior surface rests upon the superior straight muscle of the eye.

Relaxation of this muscle, as in sleep or as an effect of paralysis, is attended with passive closure of the lids, but active occlusion depends upon contraction of the orbicular muscle. The lower lid is not provided with a corresponding muscle, but is depressed partly by the natural elasticity of the parts, the orbicular being relaxed, and partly by a slight protrusion of the ball of the eye when the upper lid is elevated.

Of the six muscles proper to the ball of the eye, four are called straight, and two oblique.

The Straight Muscles of the Eye are all flat and ribbonlike. They originate by pointed extremities from the apex of the orbit or its immediate vicinity, whence they diverge as they proceed forward, curve over the globe of the eye, and are inserted by broad, thin tendons into the sclerotic coat, a short distance from the circumference of the cornea. Although so much alike, they differ somewhat in length, size, and obliquity; thus, the superior is the thinnest and narrowest; the external, the longest and most slanting; and the internal, the shortest and thickest, and almost perfectly straight. At their insertions, the tendons spread out in front of the sclerotic; and, being connected at their contiguous borders by means of the ocular fascia, form a continuous aponeurotic membrane, which is sometimes, but improperly, called the *albugineous tunic*.

Fig. 251.



Muscles of eyeball. A, ball of eye. 1, elevator of upper lid; 2, superior oblique or trochlear muscle; 3, pulley of same; 4, superior straight muscle; 5, inferior straight muscle; 6, external straight muscle; 7, ligament of Zinn; 8, origin of superior oblique muscle; 9, origin of external straight muscle; 10, inferior oblique muscle; 11, optic nerve; 12, malar bone divided; 13, superior maxillary bone.

The **Superior Straight Muscle** (*rectus superior*, Fig. 251, $_4$) originates by short tendinous fibres from the upper margin of the optic foramen and from the sheath of the optic nerve, passes forward and a little upward, expands to half an inch in breadth, and ends in an aponeurotic tendon, which curves over the superior part of the globe of the eye, and is inserted into the sclerotic coat three or four lines from the circumference of the cornea.

Relations.—Superiorly, with the elevator of the upper eyelid, a layer of fascia intervening; inferiorly, with the optic nerve, ophthalmic artery, nasal nerve, and the reflected portion of the superior oblique muscle, from all of which it is separated by processes of fascia and by more or less adipose tissue.

The **Inferior Straight Muscle** (Fig. 251, $_5$, *rectus inferior*) arises, in common with the internal and external straight muscles, from the lower part of a semicircular tendinous band, called the ligament of Zinn, that surrounds the lower half of the optic foramen; it passes forward and a little downward, curves over the lower surface of the ball of the eye, and is inserted by a broad, thin tendon into the sclerotic coat opposite to the preceding, and about the same distance from the cornea.

Relations.—Superiorly, with the optic nerve, the ball of the eye, and the adipose tissue of the orbit; inferiorly, with the floor of the orbit, from which it is separated in front by the inferior oblique muscle.

Fig. 252.

Insertion of straight muscles, with anterior ciliary arteries.

The **Internal Straight Muscle** (*rectus internus*), the shortest and thickest of the group, arises in common with the two preceding from the semicircular ligament, and from the optic sheath. It passes horizontally forward, and ends in an expanded tendon, which is inserted into the sclerotic coat about three lines from the inner border of the cornea.

Relations.—By its internal surface, with the inner wall of the orbit; and by its external, with the optic nerve, intermuscular tissue, and eyeball. Along its upper border may also be observed the anterior and posterior ethmoidal vessels and the nasal and supraorbital nerve.

The **External Straight Muscle** (*rectus externus, abductor oculi*, Fig. 251, $_6$), the longest and most oblique of the group, arises by two heads, one from the semicircular ligament, and the other in common with the

superior straight muscle from the margin of the optic foramen. It passes forward and outward, and is inserted, like the others, by a broad tendon into the sclerotic coat, about four lines from the cornea.

Relations.—Between the two heads of this muscle, the third and sixth nerves and the nasal branch of the fifth enter the cavity of the orbit. Its internal surface is in contact with the intermuscular adipose tissue, the ophthalmic artery and vein, the optic, third, nasal, and sixth nerves, and the ciliary ganglion and branches. Its external surface is in relation with the external wall of the orbit, and, at the anterior extremity, with the lachrymal gland and ducts.

Actions.—The straight muscles of the eye turn the cornea or clear part of the organ in the direction of the particular muscle brought into action. When two adjacent ones contract at the same time, rotation is in the direction of the diagonal of the two forces; and when they all contract at once, they retract the organ slightly in the direction of the axis of the orbit.

The Oblique Muscles of the Eye, two in number, are distinguished by their relative position, one being situated above, the other below the eyeball.

The **Superior Oblique** or **Trochlear Muscle** (*obliquus superior*, Fig. 251, $_2$), long and slender, arises by a delicate tendon from the margin of the optic foramen, between the internal and superior straight muscles and from the sheath of the optic nerve, and proceeds forward and a little upward and inward, toward the internal angular process of the frontal bone; behind this process it forms a small round tendon, which passes through a fibro-cartilaginous pulley or loop, attached to a small depression upon the surface of the bone in this situation, and provided with a synovial bursa; it then turns downward, backward, and outward, beneath the anterior third of the superior straight muscle, to be inserted into the sclerotic coat between the superior and external muscles, and about midway between the cornea and the entrance of the optic nerve.

The **Inferior Oblique Muscle** (Fig. 251, $_{10}$) is situated in the forepart of the orbit, below the globe of the eye. It arises by a short rounded tendon from the margin of the superior maxillary bone, between the infraorbital foramen and lachrymal groove, and forms a thin fleshy fasciculus, which passes outward and backward in a curved manner, beneath the globe of the eye and the anterior extremity of the inferior straight muscle, and is inserted by a tendinous expansion immediately below the insertion of the superior oblique.

Actions.—The superior oblique acts from the point of its reflection, and is generally considered to rotate the eyeball upon its antero-posterior axis, draw it slightly forward, and turn the cornea downward and outward.

The inferior oblique also rotates the organ upon its antero-posterior axis, but in an opposite direction, assists the superior in drawing it forward, and turns the cornea upward and inward.

The Ocular Fascia.—In dissecting the muscles of the eye, the student should not neglect to notice the fascia by which they are surrounded and separated from one another. It is a loose, thin, but tolerably consistent membrane, which forms a common investment for all the structures behind the globe of the eye, and is prolonged forward over the tendons of the muscles to the tarsal cartilages, and upon the anterior part of the sclerotic coat, where it forms the medium of attachment between this tunic and the reflected portion of the conjunctiva. It not only forms a common covering for the muscles, but also separate and distinct sheaths for them, which are continued as far as their insertion, and there attached to the sclerotic coat. This fact should be borne in mind in operating for strabismus, for, owing to this arrangement, if only the muscle upon which the obliquity of the eye depends is divided, the deformity may still remain unrelieved.

GLOBE OF THE EYE.

The Globe or Ball of the Eye is almost regularly spherical in shape, but, viewed in profile, presents a somewhat greater convexity in front, corresponding to the situation of the cornea. In point of size it is not subject to great variety, and measures in general about eleven lines in its antero-posterior diameter, and ten in its vertical and transverse, the greater length of the antero-posterior being dependent upon the prominence of the cornea. It is situated in the forepart of the orbit, occupying, however, on account of its relatively small size, but a small part of this cavity, and is held in its position by the conjunctiva, muscles, and other structures attached to its exterior. Its posterior semicircumference is imbedded in a mass of adipose tissue which fills the intervening spaces of the muscles, and the absorption of which, as in protracted fevers and other wasting diseases, causes the eye to sink within the orbit, and gives to the part that unpleasant hollow appearance so familiar to every one.

In a philosophical point of view, the eye is a complicated dioptric instrument, and consists essentially of a sentient nervous membrane placed in a dark chamber, with a single aperture, closed by a transparent structure, for the admission of the rays of light. Anatomically considered, it is composed of a series of superimposed layers, called tunics or coats, inclosing a number of fluids or humors, and a movable diaphragm called the iris. The external tunic or coat consists of two parts, one called the *sclerotic coat* and the other the *cornea.* Within the sclerotic is the *choroid coat,* next to which is the *retina* or nervous membrane. The

humors are the *aqueous*, the *crystalline lens*, with its inclosing capsule, and the *vitreous humor*, also provided with a special secreting membrane named the *hyaloid*. The *iris* is usually enumerated among the tunics, but is entirely different in its structure and uses, as will be presently seen.

Dissection.—For most purposes, the eyes of some of the larger inferior animals answer as well as those of the human subject, and being readily procured in a fresh state, and more easily dissected, the student is advised to employ them until he shall have gained sufficient knowledge of the general structure of the organ and skill in manipulation, to enable him to make a proper examination of the human eye. Having obtained, therefore, a number of ox eyes or sheep's eyes, let him commence by clipping off, with a pair of sharp scissors, all the muscles, fat, and areolar tissue from the circumference of the globe, so as to expose the sclerotic coat and cornea. Having treated one or two eyes in this way, he may divide one in an antero-posterior direction, and turn out its contents for the purpose of examining the internal surface of the external tunic.

The **Sclerotic Coat** is a dense, white, fibrous membrane, upon which the strength and form of the eye depend. It forms a kind of shell or case for the protection of the delicate parts within, and constitutes about four-fifths of a regular sphere, the deficiency corresponding to the situation of the transparent cornea. It is perforated behind, about a line and a half to the inner side of the antero-posterior axis of the eye, by the fibres of the optic nerve, and is continuous here with the fibrous sheath which this nerve receives from the dura mater. Its external surface is of a pearly white glistening appearance, covered in front by the conjunctiva and the expanded tendons of the straight muscles, and in contact behind with the adipose substance that fills this part of the orbit, a loose areolar tissue intervening. Its internal surface is in relation, throughout its whole extent, with the choroid coat, from the black pigment of which it receives a light brownish color; but when this is washed off, the surface presents a smooth, white, glossy appearance.

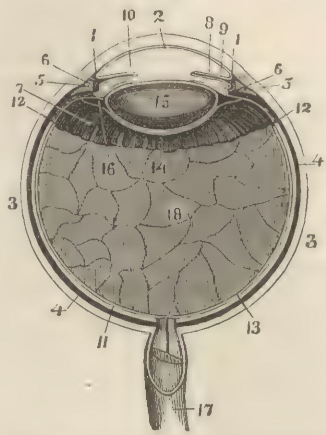
The sclerotic coat is thickest behind, in the vicinity of the entrance of the optic nerve, from which point it becomes gradually thinner toward the cornea. In point of structure it is a true fibrous membrane, its fibres interlacing in every direction. It is perforated at various points behind by numerous nerves and vessels on their way to the choroid coat and iris, but is itself almost devoid of vascularity and sensibility in the healthy state.

The **Cornea** is a transparent concavo-convex disk, of firm elastic structure, accurately fitted to the deficiency in the sclerotic coat in the forepart of the eye; and, being the segment of a smaller sphere than the latter, it renders this part of the organ a little more prominent. The degree of its convexity varies in different individuals and at different ages, being generally greatest in near-sighted persons and children. Its outline or margin is almost circular, but slightly elongated in a transverse direction; its thickness is nearly the same at all points. The anterior surface of the

cornea is covered by a continuation of the epithelium of the conjunctiva; its posterior or concave surface is also lined by epithelium, and forms the anterior boundary of the anterior chamber of the eye.

Structure.—The cornea consists of five separate structures, which, commencing with the most external, are, the conjunctival epithelium, the anterior elastic lamina, the cornea proper, the posterior elastic lamina, and the epithelium of the anterior chamber.

Fig. 253.



Horizontal section of eye. 1, 1, cornea, fitted into sclerotic; 2, its posterior elastic lamina, forming anterior parietes of chamber of aqueous humor; 3, 3, sclerotic; 4, 4, choroid coat; 5, 5, ciliary ring or ligament; 6, its internal surface, corresponding to ciliary processes; 7, ciliary body or corona ciliaris of choroid coat; 8, iris; 9, posterior chamber, 10, anterior chamber, of aqueous humor; 11, retina; 12, 12, termination of retina, according to Cruveilhier and others, at posterior extremities of ciliary processes of vitreous body; 12, vitreous humor; 13, hyaloid tunic, one layer of which, 14, passes behind, the other in front of, crystalline lens; 15, lens; 16, canal of Petit; 17, optic nerve, invested by sheath from dura mater; 18, vitreous humor.

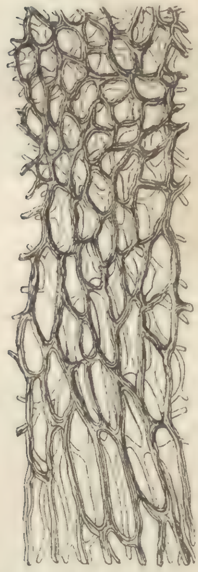
The elastic laminæ are two thin layers of transparent membrane, situated, the one in front of and the other behind the cornea proper, and beneath the corresponding epithelial layers. Their structure resembles that of cartilage, being homogeneous throughout, and they are remarkable for not losing their transparency by boiling or protracted maceration. Their use seems to be to preserve the form of the cornea, for which they are eminently fitted by their great density and elasticity. The posterior of the two is much thicker than the anterior, the latter being scarcely distinguishable from the proper tissue of the cornea.

The cornea proper is a modified form of white fibrous tissue, and consists of a great number of superimposed lamellæ which, although closely connected, may be made to glide slightly upon each other by pressing the cornea obliquely between the thumb and finger. The fibres of which the lamellæ are composed cross each other in every direction, leaving elongated interstices, and are continuous with those of the sclerotic. The tissue connecting the lamellæ is of the same nature, but its interstices have a tubular form, and do not communicate with each other.

Anatomists have almost universally failed to demonstrate the presence of bloodvessels in the healthy cornea, but from the fact that this structure, when divided, is known to unite readily by the adhesive process, and is moreover subject to deposition of lymph between its laminæ, and to ulceration in all its forms and stages, its non-vascularity has not been generally admitted. Two sets of vessels surround its margin, and anas-

tomose here in the form of an intricate vascular zone, the superficial being continuous with those of the conjunctiva, and the deep with the short ciliary arteries which penetrate the sclerotic in the immediate vicinity to reach the iris. From the margin of this zone, vessels are said to have been demonstrated to enter the cornea and penetrate between its laminæ.

Fig. 254.



Section of sclerotic and cornea at junction between them, magnified 54 diameters. In sclerotic, spaces between fibrous tissue are seen to be more or less rounded, while in cornea they are elongated and tubular.

No *nerves* have ever been traced into the cornea, but they no doubt exist, for its conjunctival layer is one of the most highly sensitive structures in the body.

Dissection to expose the Choroid Coat.—Take an eye that has been perfectly freed from muscles, areolar tissue, fat, etc. (one that is two or three days old is preferable), and having made a small opening with a sharp scalpel through the sclerotic coat, two or three lines from the cornea, introduce a pair of blunt-pointed scissors, and by successive short cuts divide the sclerotic in a circular manner entirely around the organ. From different parts of this circular incision three or four others may be made in the direction of the optic nerve, when by a little care the several sections may be separately turned back, the connecting areolar tissue and the vessels and nerves that pass from one membrane to the other being divided as occasion requires. This dissection is best performed under water.

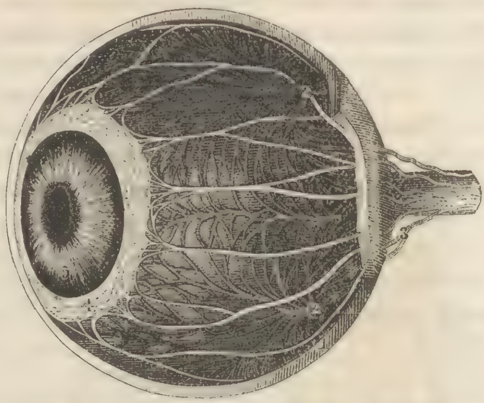
The **Choroid Coat** is a fibro-vascular membrane, of a deep brown or chocolate color, situated between the sclerotic coat and the retina. Traced from the entrance of the optic nerve, by which it is perforated behind, it extends as far forward as the junction between the sclerotic and cornea, to which it is connected by means of a circular band, known as the *ciliary ligament*. Here it turns in toward the antero-posterior axis of the eye in the form of a folded flattened ring, called the *ciliary body*, the inner circumference of which slightly overlaps the margin of the crystalline lens. The ciliary body will demand a separate examination after the other portion of the membrane has been properly studied.

The outer surface of the choroid presents a loose flocculent appearance, and is connected to the inner surface of the sclerotic by soft areolar tissue, and by the numerous ciliary vessels and nerves which perforate the former and pass forward between it and the choroid on their way to the iris. The internal surface is smooth and glossy, and in contact with the retina as far forward as the ciliary ligament.

Structure.—The choroid coat consists of two layers of bloodvessels, held together by fibro-areolar tissue, and one of epithelium. The outer

layer is composed almost entirely of minute veins, which, when injected and the black pigment washed off, will be found disposed in beautiful arborescent tufts or whorls; and from the centre of these proceed veins of larger size, which, uniting together, form five or six main trunks, that perforate the sclerotic coat behind to terminate in the ophthalmic vein.

Fig. 255.



Choroid coat, ciliary ligament and nerves, as seen after removal of sclerotic coat. 1, sclerotic coat; 2, 2, veins of choroid; 3, ciliary nerves; 4, ciliary ligament; 5, iris.

The middle layer is formed by the short ciliary arteries, which, having penetrated the sclerotic, pass outward, and anastomose freely with each other as far forward as the ciliary ligament. The internal layer is a tessellate epithelium, and composed of hexagonal cells containing a large amount of black pigment.

The coloring matter of the choroid is found in greatest abundance in the epithelial layer, but is also largely disseminated throughout the vascular laminæ, from the interstices of which it may be removed by means of a soft brush.

The **Ciliary Ligament** is situated at the junction of the cornea, sclerotic, and choroid membranes, where it forms a ring of a grayish-white color and triangular outline. It constitutes the bond of union between the choroid, sclerotic, ciliary body, and iris, and is pierced by the ciliary nerves and long ciliary arteries. Between it and the sclerotic is said to be a small circular vein, called the canal of Fontana.

In connection with the ciliary ligament some anatomists describe, under the name of the *Ciliary Muscle*, a circular band of unstriped muscular fibres, which are attached upon the one hand to the line of junction of the sclerotic, and upon the other to the outer surface of the ligament. Its action would be to advance the ciliary body and lens toward the cornea. This muscle is well developed in birds, but its existence in the human subject is not universally admitted.

The **Ciliary Body** is best seen by making a circular division of the sclerotic, choroid, and retina, about a quarter of an inch behind the circumference of the cornea, and, the posterior segment having been removed, the body may be viewed from behind through the medium of the vitreous

humor. It is a dark, brownish-black, circular, flattened ring, formed by a folding in of the choroid coat upon the forepart of the vitreous body. Its folds, called the *Ciliary Processes*, are sixty or seventy in number, triangular in shape, and alternately long and short. It is connected by its periphery or greater circumference to the ciliary ligament, while its inner border is free and slightly overlaps the margin of the crystalline lens. The anterior surface corresponds to the posterior surface of the iris, from which it is separated by a narrow interval, occupied by the aqueous humor, and called the posterior chamber of the eye; the posterior rests upon the anterior surface of the vitreous body, which presents a corresponding number of triangular grooves into which the ciliary processes are received. The ciliary body does not differ in structure from the rest of the choroid coat, except in the greater abundance of the black pigment, and the absence of the vorticose arrangement of its vessels.

The **Iris** (Figs. 255 and 256) is a circular membranous diaphragm, with an opening in the centre, called the *pupil*, and is intended to regulate the amount of light admitted into the eye. It is situated in the aqueous humor, between the cornea and crystalline lens, but much nearer to the latter, and divides the space into two unequal parts, called respectively the anterior and posterior chambers of the aqueous humor. It is attached by its outer border or greater circumference to the anterior edge of the ciliary ligament; its inner or lesser border is free, floats in the aqueous humor, and corresponds to the aperture of the pupil. The anterior surface is variously colored in different individuals, and, when closely examined, will be found marked by numerous lines or ridges radiating from the pupillary margin toward the greater circumference; the posterior is covered by a thick layer of pigment, which gives it a bluish appearance, like that seen upon the inner surface of the choroid, and is called the *uvea*, from its resemblance in color to a grape.

The *Pupil* is not situated exactly in the centre of the iris, but a little to the inner or nasal side. It is of a circular form, communicates between the anterior and posterior chambers of the aqueous humor, and varies in size at different times, according as more or less light is to be admitted to the back part of the eye. Throughout the greater part of fœtal life, this opening is closed by a delicate membrane called the *pupillary membrane*, the vessels of which are continuous with those of the iris, and form loops meeting at the centre. About the seventh or eighth month, the membrane breaks at the centre, and the vascular loops gradually contract toward the future site of the pupillary margin. Not unfrequently shreds of this membrane may be seen in the eyes of new-born children, and occasionally the membrane remains entire until some days after birth.

Structure.—The iris is a muscular membrane, covered upon both surfaces with pigment, and largely furnished with bloodvessels and nerves.

The *muscular fibres* of the iris belong to the involuntary or unstriped variety, and are arranged into two sets, one radiating from the pupil toward the larger circumference of the membrane, and the other surrounding the pupil in the form of a circular band; the former dilate the pupil, and the latter contract it. In birds, the radiating fibres are said to be striped.

Fig. 256.

Arteries of iris. 1, long ciliary arteries; 2, 3, their principal divisions; 4, small branches to ciliary muscle; 5, 6, anterior ciliary arteries; 7, pupil.

The *pigment cells*, as stated above, are most abundant upon the posterior surface of the membrane, and are very irregular in size and form. Those upon the anterior surface are less numerous and variously colored in different individuals.

Vessels and Nerves.—The *long ciliary arteries*, two in number, are derived from the ophthalmic; they perforate the sclerotic coat, and proceed horizontally forward between this membrane and the choroid to the ciliary ligament; before reaching this point, they each divide into a superior and an inferior branch, and, from the subdivisions and anastomoses of these branches upon the larger circumference of the iris, a vascular zone is formed, from which numerous twigs proceed in the substance of the membrane in the direction of the pupil. While lying between the sclerotic and choroid coats, the internal of these two arteries is situated a little below, and the external a little above the transverse axis of the eye. This circumstance should be borne in mind in the introduction of the needle in operating for cataract. The *short* or *anterior ciliary arteries* are numerous, and much smaller than the preceding; they anastomose

in the form of a zone beneath the conjunctiva and immediately behind the circumference of the cornea, and then perforate the sclerotic coat to join the deeper zone formed by the long ciliary arteries. It is from the congestion of the branches of the short ciliary arteries that the red zone around the cornea is produced in inflammation of the iris.

The *veins* of the iris follow the same course as the arteries.

The *ciliary nerves*, fifteen or twenty in number, and remarkably large considering the small size of the iris, are derived from the ophthalmic or lenticular ganglion and nasal branch of the fifth pair; they perforate the sclerotic at different points, proceed forward upon the surface of the choroid to the ciliary ligament, and within this ligament divide minutely, and then enter the substance of the iris.

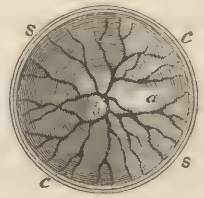
Dissection of the Retina.—The retina cannot be perfectly dissected except under water. The sclerotic coat having been removed as before directed, the student should take two pairs of blunt forceps, one in each hand, and, having pinched up the choroid with one, in order to hold the membrane steady, he can then with the other tear it off in small pieces, taking great care not to get the retina in the grasp of the forceps or to let the eye roll about in a forcible manner.

The **Retina** lies between the chorid coat and the vitreous body, and extends from the entrance of the optic nerve to the circumference of the ciliary body, where it ends in a serrated border. It is thin and delicate, of a pulpy consistence, and nearly transparent during life, but after death it assumes an opaque milky hue. Its outer surface is connected loosely to the choroid, and presents a ragged flocculent appearance. The inner surface rests upon the vitreous body, and is marked behind, directly in the

Fig. 257.

Eyeball, with sclerotic, cornea, choroid, and iris removed. 1, optic nerve; 2, 3, retina; 4, central artery of retina entering eyeball through optic nerve and distributed to retina; 5, 6, ciliary zone, at which ciliary folds of choroid impress vitreous humor; 7, space of hyaloid membrane at circumference of crystalline lens, artificially inflated at 8, and assuming form of beaded canal.

Fig. 258.



Yellow spots of Soemmering, seen in axis of eye, with entrance of central artery of retina about eighth of an inch on inner side of axis. *a*, yellow spot; *b*, point of entrance of optic nerve; *c*, choroid coat; *s*, sclerotic coat.

antero-posterior axis of the eye, by a small yellow spot called the *spot of Soemmering.** About two lines to the inner or nasal side of the yellow

* The yellow spot exists only in man and those animals the visual axes of whose eyes are parallel.

spot is a little papilla corresponding to the extremity of the optic nerve, and, extending between these two points, a delicate fold, which is produced after death. Emerging from the papilla will also be seen the central artery of the retina, which enters the eye in the substance of the optic nerve, and ramifies upon the retina.

Structure.—The retina consists of at least four distinct layers, and some anatomists describe as many as six.

The external layer, commonly called *Jacob's membrane*, is composed of a single stratum of minute cylindrical cells or tubes arranged perpendicularly to the surface, and projecting by their outer extremities a short distance into the substance of the choroid. Soon after death the cells become disorganized and broken up, and give to the exterior the loose areolar appearance already alluded to.

Beneath the preceding is a soft pulpy layer, the external surface of which is composed of granules or nucleolated nuclei, and the deeper portion of nerve cells resembling those found in the gray substance of the brain and spinal cord.

Next is the fibrous or medullary layer, made up of nerve fibres derived from the optic nerve. The innermost layer is composed principally of the ramifications of the central artery, held together by means of areolar or connective tissue.

HUMORS OF THE EYE.

The Humors of the Eye are transparent, refracting media of different consistence, through which the light passes from the cornea on its way to the retina. They serve also to give fullness and rotundity to the organ. They are the vitreous body, crystalline lens, and aqueous humor.

The **Vitreous Body** is a clear, transparent, gelatinous mass, of spheroidal form, occupying the posterior three-fourths of the interior of the eye. Although apparently a homogeneous structure, it consists of a delicate investment called the hyaloid membrane, and an inclosed fluid which is the vitreous humor.

The *Hyaloid Membrane* is an exceedingly delicate, transparent structure, which not only forms the exterior covering of the vitreous body, but gives off numerous membranous processes from its inner surface, by which the inclosed space is divided into a great many small compartments (Fig. 253). The number of these compartments is over a hundred and fifty, all communicating with each other, and mostly of an angular form. Those surrounding the antero-posterior axis of the organ are said to be wedge-shaped, their sharp edges presenting toward each other, and inclosing a minute canal.

The *Vitreous Humor* occupies the compartments of the hyaloid mem-

brane; it is a clear, limpid fluid, about the consistence of slightly viscid mucilage, and composed of pure water holding in solution about two per cent. of animal and saline matters.

The circumference of the vitreous body is in contact with the entire internal surface of the retina, and presents in front a circular excavation for the reception of the greater convexity of the crystalline lens. The surface surrounding the lens is in close contact with the ciliary processes, from which it receives a brownish discoloration, and is marked by a like number of radiating ridges, forming what is called the *ciliary zone* or *zone of Zinn.* The ridges correspond in number to the ciliary processes, between which they are accurately fitted, but are much less prominent.

Immediately around the margin of the crystalline lens the hyaloid membrane separates into two layers, one of which passes in front of the lens and the other behind it. The narrow triangular passage thus left around the circumference of this body presents a beaded appearance when inflated, and is called the *canal of Petit* (Fig. 253).

No vessels or nerves can be traced into the vitreous body in the adult, but, in the fœtus, a small arterial twig proceeds from the central artery of the retina through the middle of the organ from behind forward, to reach the back part of the crystalline lens, upon which it is distributed.

The **Crystalline Lens** is a transparent semisolid body, having a double convex form. It is situated directly in the axis of the eye, a short distance behind the pupil, and imbedded in the cup-shaped depression upon the anterior surface of the vitreous body. The anterior surface is slightly convex, and covered by the hyaloid membrane; it forms the posterior wall of the posterior chamber of the aqueous humor, by which it is separated from the iris, and, when the pupil is widely dilated, it is exposed to view throughout almost its entire extent. The posterior surface is more convex than the anterior, and accurately fills the concavity upon the fore-part of the vitreous body. The circumference is inclosed by the separation of the hyaloid membrane, surrounded by the canal of Petit, and very slightly overlapped by the points of the ciliary processes.

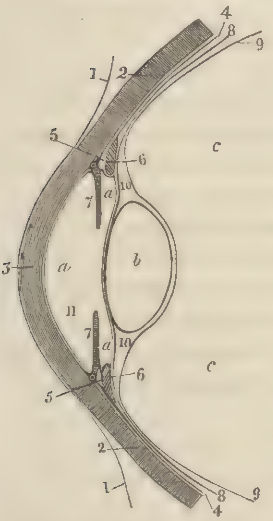
The crystalline lens consists of an investing membrane, called the capsule, and an inclosed substance, which is the lens proper, sometimes called the body of the lens.

The *capsule of the lens* is a firm, transparent membrane, much thicker in front than behind, and composed of an elastic horny tissue precisely similar to the posterior elastic lamina of the cornea.

The *proper substance* of the lens is separated from the interior of the capsule by a minute quantity of watery fluid, which is supposed, however, to result from post-mortem imbibition. In the fresh state, it appears to be a firm and jellylike transparent mass, semifluid upon its exterior, but increasing in consistence toward the centre, where it forms a small round

nucleus of horny firmness. When hardened in alcohol, it readily separates into three wedge-shaped segments, each one of which may be resolved into a large number of superimposed lamellæ, and these lamellæ are found, under the microscope, to consist of transparent flattened fibres with serrated edges.

Fig. 259.



Plan of structures in forepart of eye, seen in section. 1, conjunctiva; 2, sclerotic; 3, cornea; 4, choroid; 5, ciliary ligament; 6, ciliary processes; 7, iris; 8, retina; 9, hyaloid membrane; 10, canal of Petit (enlarged); 11, membrane of aqueous humor (thickened). *a*, aqueous humor, anterior and posterior chambers; *b*, crystalline lens; *c*, vitreous humor.

Fig. 260.

Lens, hardened in spirit and partially divided along three interior planes, as well as into lamellæ; magnified 3½ diameters.

No vessels or nerves exist in the crystalline lens, but, in the fœtus, a small arterial twig may be traced from the middle artery of the retina through the centre of the vitreous body to the back part of the capsule.

The crystalline lens differs in several important particulars at different periods of life. Thus, in the fœtus, it is nearly spherical, of a pinkish color, and almost fluid consistence; in the adult, it is perfectly transparent, of moderate firmness, and much more convex upon its posterior than its anterior surface; in old age it is often of a yellowish tinge, tough, and sometimes almost horny in its consistence, and somewhat flattened upon both surfaces.

The **Aqueous Humor** is a thin, transparent fluid, occupying the interval between the cornea in front and the crystalline lens and ciliary processes behind. This space is divided by the iris into two unequal parts, called the *Anterior* and *Posterior Chambers of the Eye.* The former is much the larger, and communicates with the latter through the pupil. The aqueous humor does not usually exceed five or six grains in weight, and consists of pure water, holding in solution about two per cent. of chloride of sodium and a minute quantity of albumen.

The aqueous humor is supposed, by some anatomists, to be derived

from the vitreous body, and, by others, to be secreted from the membrane forming the posterior lamina of the cornea, which is therefore sometimes called the capsule of the aqueous humor.

VESSELS AND NERVES OF THE ORBIT.

The structures within the orbit are supplied almost entirely by the Ophthalmic Artery, in addition to which, however, a few small twigs are received from the facial, temporal, and internal maxillary.

The **Ophthalmic Artery**, a vessel about the size of an ordinary pocket probe, arises from the internal carotid upon the inner side of the anterior clinoid process of the sphenoid bone, passes forward through the optic foramen beneath the optic nerve, but soon leaves this nerve to its inner side, and then turns obliquely across its upper surface to reach the nasal side of the orbit, in which situation it proceeds in a tortuous manner toward the inner angle of the eye, where it divides into a nasal and a frontal branch. In its course it gives off the following branches:

The *Lachrymal*, one of the largest of the branches of the ophthalmic, arises from the main trunk close to the optic foramen, passes forward between the external straight muscle and outer ball of the orbit, and is distributed to the lachrymal gland and upper eyelid.

The *Central Artery of the Retina*, very small, arises near the preceding, enters the substance of the optic nerve, and in this relation reaches the interior of the ball of the eye, where it divides minutely to supply the retina; in the fœtus, it sends a small twig through the vitreous body to the back part of the crystalline lens.

The *Anterior* or *Short Ciliary Arteries*, ten or twenty in number, and very small, arise from various parts of the ophthalmic, proceed forward around the optic nerve, and perforate the sclerotic coat of the eye a short distance behind the cornea, to be distributed principally to the iris.

The two *Long Ciliary Arteries* arise from the outer side of the ophthalmic near the back part of the eyeball, perforate the sclerotic coat on each side of the optic nerve, and proceed forward upon the surface of the choroid coat to the iris, the internal situated a little above, and the external a little below the transverse axis of the eye.

The *Muscular* branches, from three to five in number, supply the straight and oblique muscles of the eye and the elevator of the upper eyelid.

The *Ethmoidal Artery* arises near the posterior internal orbital foramen, through which it reaches the ethmoidal cells, and is distributed to the lining mucous membrane; it also sends a few twigs through the cribriform plate of the ethmoid bone to the anterior extremity of the cerebral falx.

The *Superior and Inferior Palpebral* branches arise near the preceding, and are distributed to the eyelids, lachrymal caruncle, conjunctiva, and lachrymal sac.

The *Supraorbital*, one of the largest of the branches of the ophthalmic, originates far back, proceeds forward between the elevator of the upper eyelid and roof of the orbit, emerges at the supraorbital notch, and is distributed to the orbicular and occipito-frontal muscles.

The *Nasal* branch, one of the terminal divisions of the ophthalmic, leaves the orbit above the ocular tendon, and descends upon the side of the nose, inosculating with the nasal branches of the facial.

The *Frontal* branch leaves the orbit at its superior internal angle, and is distributed to the skin of the upper eyelid and forehead, and subjacent muscles.

The **Veins** from the eyelids and inner part of the orbit terminate in the veins of the forehead and face; those from the eyeball and its muscles correspond to the arterial branches, and unite to form a single main trunk, the *Ophthalmic Vein*, which proceeds backward below the external straight muscle, traverses the sphenoidal fissure, and opens into the cavernous sinus.

The visual organs receive the entire distribution of the second (optic), third, and fourth, and branches from the fifth, facial, and sympathetic Nerves.

The **Optic Nerve** enters the orbit through the optic foramen, accompanied by the ophthalmic artery, proceeds forward and a little inward, and, having reached the eyeball, perforates the sclerotic and choroid coats about a line and a half to the inner side of the antero-posterior axis of the organ. Upon leaving the cranial cavity it is covered by a strong fibrous sheath, which is continuous on the one hand with the dura mater, and on the other with the sclerotic coat of the eye. In its course through the orbit it is surrounded by the muscles of the eye, a large quantity of adipose tissue, the ophthalmic artery and its branches, and the nerves next to be mentioned.

The **Ophthalmic Nerve**, the first branch of the fifth pair, arises from the upper part of the Gasserian ganglion, traverses the cavernous sinus, enters the orbit through the sphenoidal fissure, and divides into three branches, namely, the frontal, lachrymal, and nasal.

The *Frontal* branch proceeds forward between the elevator muscle of the upper lid and the roof of the orbit, and, emerging at the supraorbital notch, is distributed principally to the skin of the forehead. In its course within the orbit it sends off the supratrochlear branch to the upper part of the superior oblique or trochlear muscle, and a small filament to join the infratrochlear nerve.

The *Lachrymal* branch passes along the superior and external part of the orbit, and supplies the lachrymal gland, conjunctiva, and upper eyelid.

The *Nasal* branch crosses obliquely below the superior straight muscle to gain the superior inner part of the orbit, and enters the anterior internal orbital foramen. Before reaching this point, it sends filaments to the lenticular ganglion, several twigs of considerable size, called the *long ciliary nerves*, to the ball of the eye, and a single branch, named the *infratrochlear nerve*, to the parts about the inner canthus of the eye.

Fig. 261.

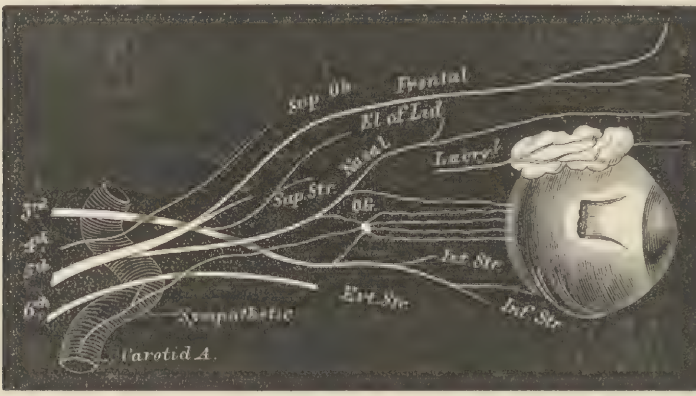


Diagram of nerves of orbit, and their relation to ball of eye, ophthalmic ganglion (O. G.), and muscles of eye (external straight, elevator of lid, superior oblique, etc.).

The **Fourth Nerve** (*trochlearis* seu *patheticus*) enters the orbit through the sphenoidal fissure, passes obliquely across the commencement of the elevator muscle of the eyelid in close connection with the lachrymal branch of the ophthalmic nerve, and is distributed exclusively to the superior oblique or trochlear muscle of the eye.

The **Third** or **Common Motor Nerve of the Eye** passes from its origin through the external wall of the cavernous sinus, lying to the outer side of the internal carotid artery and upon the inner side of the fourth and ophthalmic nerves, receives a filament from the sympathetic and one from the ophthalmic nerves, and there divides into a superior and an inferior branch, which enter the orbit through the sphenoidal fissure. The *superior* division proceeds forward and upward beneath the superior straight muscle, and divides into a great number of branches, most of which are distributed to this muscle, and the others to the elevator of the upper lid and internal straight muscle. The *inferior* division, the larger of the two, passes forward between the optic and the sixth nerves, and divides into three branches, which are distributed respectively to the internal and external straight and inferior oblique muscles.

The **Sixth or External Motor Nerve of the Eye** (*abducens*), after traversing the external wall of the cavernous sinus, where it receives filaments from the carotid plexus of the sympathetic, enters the orbit through the lower part of the sphenoidal fissure, and, crossing obliquely beneath the ophthalmic nerve, enters the external straight muscle, to which it is exclusively distributed.

The **Ophthalmic** or **Lenticular Ganglion**, to which reference has been so often made in the preceding pages, is a very small, irregularly quadrilateral, grayish-looking body, situated upon the outer surface of the optic nerve, two or three lines in front of the optic foramen. It receives from behind a filament from the nasal branch of the ophthalmic, to which it in all probability belongs, one from the third nerve, and an exceedingly small one from the sympathetic, and gives off from its anterior angles two fasciculi, containing altogether about twenty nerves called the *Ciliary Nerves*, which proceed forward around the optic nerve to the ball of the eye, perforate the sclerotic coat, and are distributed principally to the iris.

THE EAR.

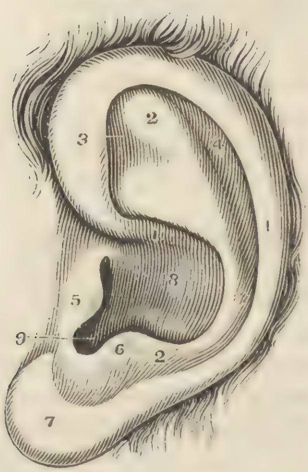
The Ear is divided into three parts, named, from their relative position, external, middle, and internal.

THE EXTERNAL EAR.

The External Ear comprises the pinna or auricle projecting from the side of the head, and the canal or meatus leading to the tympanum.

The **Auricle** (*pinna*), to which part the term Ear is in common usage restricted, is an expanded elastic lamina intended to catch the undulations of sound and direct them into the meatus. Its size, shape, and situation are familar to every one, and do not require any special description. Its different parts have received certain technical names, with some of which it is necessary to become acquainted, on account of their frequent occurrence in referring to this organ. Thus, the large, funnel-shaped excavation situated a little below the middle and leading directly to the meatus, is called the *concha* (Fig. 262, 8); the triangular teatlike process in front of the concha is the *tragus*;[5] below the concha, and separated from the tragus by a deep notch, is another but smaller eminence called the *antitragus*;[6] the curved projecting edge of the auricle is termed the *helix*;[1] the rounded ridge in front of the helix is the *antihelix*;[2] the superficial excavation above the antihelix is the *scaphoid* or *navicular fossa*;[3] the soft appendage forming the point of the auricle, and to which the ear-ring is attached, is called the *lobule*[7] (lobus).

Fig. 262.



Pinna or auricle of external ear. 1, helix; 2, antihelix; 3, scaphoid fossa; 4, fossa of helix; 5, tragus; 6, antitragus; 7, lobule; 8, concha; 9, external auditory meatus.

The inner surface of the pinna looks toward the side of the head, and presents numerous irregularities, the reverse of those upon the opposite side.

Structure.—The pinna consists principally of a plate of fibro-cartilage, upon which the shape and elasticity of the part depends, and to this is superadded a certain amount of fibrous and muscular tissue. The lobule differs from the rest in being composed entirely of areolar and adipose tissue.

Ligaments.—The pinna is attached to the side of the head by two ligaments, one *anterior*, extending from the helix to the root of the zygoma, and a *posterior*, from the back of the concha to the mastoid process.

Muscles.—The muscles of the pinna are extrinsic and intrinsic. The *extrinsic* muscles (Fig. 191) have been already described in connection with the temporal aponeurosis upon which they rest; they are the posterior auricular (*retrahens aurem*), superior auricular (*attollens* or *elevator*), and anterior auricular (*attrahens*). The *intrinsic* muscles, four or five in number, consist of thin pale fibres passing from one part of the fibro-cartilage to another, but are so imperfectly developed in the human subject that it is scarcely necessary to mention their existence.

Vessels and Nerves.—The pinna is supplied with arterial blood by branches from the posterior auricular and temporal arteries. The nerves, few and very small, are filaments from the cervical plexus and facial nerve.

The **External Auditory Canal** or **Meatus** is the passage from the concha to the middle ear or tympanum. It is about an inch in length, slightly curved in its direction, the convexity presenting upward, and closed at its internal extremity by the membrane of the tympanum or drum of the ear.

The first half of the canal consists of a fibro-cartilaginous tube continuous with the concha; the internal half is formed by the temporal bone. It is lined by a prolongation of skin, which becomes thinner toward the drum, and upon the external surface of this membrane consists only of the epidermic layer. The skin is covered with numerous fine hairs intended to prevent the entrance of dust, and contains a number of little oval-shaped glands for the secretion of the cerumen or wax of the ear.

THE MIDDLE EAR OR TYMPANUM.

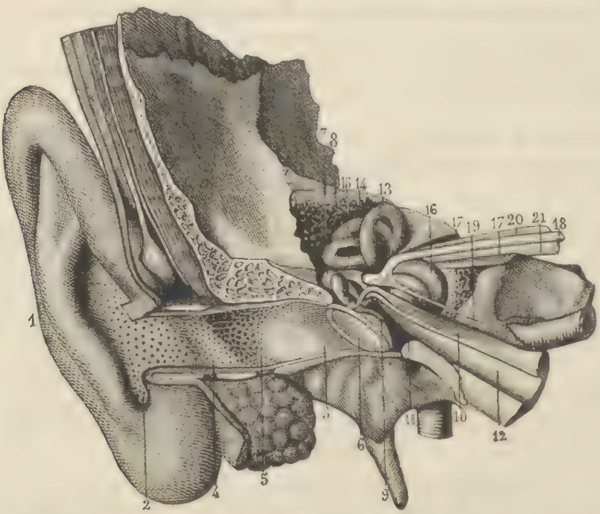
The Tympanum is a small irregular cavity situated in the substance of the petrous portion of the temporal bone, between the internal ear and the termination of the external meatus. It communicates with the cells in the mastoid portion of the bone, and, through the Eustachian tube, with

the pharynx, and contains the small bones of the ear and their special muscles.

Dissection.—The tympanum should be studied in the dried bone as well as in its recent state. It is best exposed by carefully breaking through the petrous portion of the temporal bone immediately above the cavity, and removing the fragments with a pair of forceps, or by sawing across the base of the bone, near the bottom of the external meatus, and cutting through the drum. Another good method is to macerate a fresh temporal bone in dilute muriatic acid, so as to remove its earthy part, and then with a scalpel cut away the upper wall of the cavity.

The **Cavity of the Tympanum** is irregularly oblong, and flattened from within outward, its antero-posterior and vertical diameters measuring nearly half an inch, and its transverse only about two lines. Its *superior wall* is concave, and formed by the union of the petrous and squamous portions of the temporal bone internal to the posterior root of the zygoma. The *inferior wall* is a narrow groove or trench, which crosses the base of the bony plate that separates the condyloid from the jugular fossa in an antero-posterior direction. The *external wall* is formed by the membrane of the tympanum.

Fig. 263.



General view of ear, right side, laid open from front. 1, auricle; 2, concha; 3, 4, external auditory meatus; 5, ceruminous glands; 6, membrane of tympanum; 7, incus; 8, malleus; 9, its handle inserted into membrane of tympanum; 10, tensor tympani; 11, cavity of tympanum; 12, Eustachian tube; 13, 14, 15, three semicircular canals; 16, cochlea; 17, internal auditory meatus; 18, facial nerve occupying groove of 20, 21, auditory nerve; 19, Vidian nerve.

The *internal wall*, formed of bone, is uneven, and perforated above by a small *oval opening* (fenestra ovalis) which communicates with the vestibule, but is closed in the fresh state by the base of the stapes. Above

this opening is a bony projection corresponding to the Fallopian aqueduct, and below it a rounded elevation called the *promontory*, corresponding to the first turn of the cochlea, and marked by grooves leading downward to a minute canal. The grooves lodge the tympanic plexus formed by the anastomosis of filaments from the glosso-pharyngeal, Vidian, Jacobson's, and sympathetic nerves; the canal descends inward to open upon the base of the temporal bone, between the jugular fossa and carotid canal, and gives passage to Jacobson's nerve. Behind the oval opening and promontory is a small eminence called the *pyramid*, the summit of which is perforated by a minute foramen, said to be for the passage of the delicate tendon of the stapedius muscle. Below and behind the base of the promontory is a small *round opening* (fenestra rotunda) communicating with the cochlea, but closed in the recent state by a delicate membrane, called the *secondary membrane of the tympanum.* The *posterior wall* is perforated by several small openings and one large one, which communicate with the cells of the mastoid process.

The *anterior extremity* of the tympanum is contracted and narrow, and leads to two small openings separated by a thin lamella of bone; the superior of the two lodges the tensor muscle of the tympanum, the inferior and larger is the termination of the bony part of the Eustachian tube.

The tympanum is lined throughout by a delicate mucous membrane continuous through the Eustachian tube with the lining membrane of the pharynx, and prolonged through the openings in the back of the cavity into the cells of the mastoid process.

The **Membrane of the Tympanum** (*membrana tympani*) is a circular semitransparent septum, directed obliquely downward and inward across the internal extremity of the external auditory canal, the circumference of which is here grooved for its insertion. The external surface is slightly concave, and covered by the cuticular prolongation of the skin lining the external meatus; the internal surface is correspondingly convex, covered by the mucous membrane of the tympanum, and gives attachment to the handle of the malleus, one of the ossicles of the ear. Between the cuticular and mucous layers is the proper substance of the membrane, composed of fibrous tissue, the fibres of which are fine, closely arranged, and directed for the most part from the centre toward the circumference. The use of the membrane of the tympanum is to receive the vibrations of sound, which are thence transmitted across the tympanum by the chain of small bones to the oval opening upon the inner wall, where they impinge upon the internal ear containing the expansion of the auditory nerve.

The **Eustachian Tube** is a trumpet-shaped canal, nearly two inches long, communicating between the throat and the tympanum. Its guttural

orifice is circular, and sufficiently large to admit the end of the little finger; it is situated upon the upper part of the lateral wall of the pharynx a little above and behind the posterior extremity of the inferior turbinate bone, and may be reached by a probe or catheter slightly bent near the point and introduced along the floor of the nose. From the pharynx, the tube leads upward, backward, and outward; and, having narrowed to the size of a small probe, terminates in the anterior extremity of the cavity of the tympanum.

The lower two-thirds of the Eustachian tube is composed of fibro-cartilage; the superior third is the upper of the two small bony canals found in the receding angle formed in front by the union of the squamous and petrous portions of the temporal bone. The tube is lined by a mucous membrane continuous with that of the pharynx and tympanum.

The **Small Bones** or **Ossicles of the Ear**, three in number,* form a connected chain across the upper part of the cavity of the tympanum, reaching from the convex surface of the membrane of the tympanum to the oval opening communicating with the vestibule. Their office is to conduct the sonorous vibrations from the membrane of the tympanum to the fluid contained within the internal ear. Their size, shape, and situation will be better understood by reference to Figs. 264 and 265, than from any description, however accurate.

The opposed surfaces of the bones of the tympanum are covered by thin layers of cartilage and delicate synovial membranes, and held together by surrounding ligamentous fibres. They admit, therefore, of a certain degree of motion, the object of which doubtless is to break the force of the sonorous vibrations, and thus protect the internal ear from sudden and violent impulses.

The *Malleus*, so called from its hammerlike shape, is the second in point of size, and, as regards its position, the most external of the bones of the ear. It consists of a body having a rounded head and two long processes, of which one is horizontal and the other vertical, the latter the larger of the two, and commonly called the handle (manubrium), another little offset from the base of the handle being distinguished as the short process.

The *handle* of the malleus is received between the internal and middle layers of the membrane of the tympanum, to the latter of which it is closely attached. The *horizontal process* (long process, processus gracilis), long and slender, extends obliquely downward and forward to the glenoid fissure, where it is attached by ligamentous fibres. The *short process* is in contact with the middle layer of the membrane of the tympanum near the

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* Often described as four, the orbicular bone being considered as a separate piece, rather than as a tubercle on the incus.

upper edge. The *head* projects above the membrane of the tympanum, and articulates by its inner surface with the incus.

The *Incus*, the largest of the bones of the ear, consists of an irregularly quadrangular body and two processes. The *body* is very uneven, and marked upon its upper surface by a slight concavity tipped with cartilage for articulation with the side of the head of the malleus. One of the *processes* is short and thick, directed horizontally backward, and connected to the posterior wall of the tympanum by a few ligamentous fibres; the other is long and slender, bent at its extremity, and terminated by a rounded tubercle for articulation with the stapes. The tubercle by which the long process joins the stapes is often described as a separate piece, called the *lenticular* or *orbicular bone* (os orbiculare).

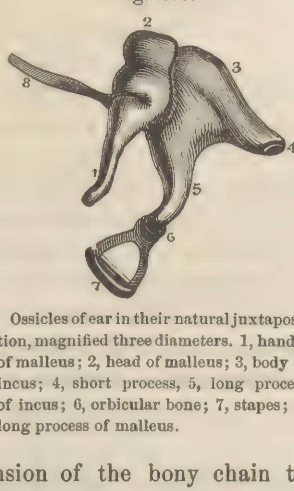
Fig. 264.

Ossicles of ear (natural size). 1, malleus; 2, incus; 3, orbicular bone; 4, stapes.

The *Stapes*, the smallest and most internal of the three bones, is shaped, as its name indicates, like a stirrup. Its head is directed outward, and presents a slight concavity for articulation with the end of the long process of the incus. The base is applied over the oval opening (*fenestra ovalis*), to the margins of which it is connected by ligamentous fibres.

Owing to the minuteness and delicacy of the Muscles of the Tympanum, different observers have arrived at very different conclusions in regard to their number. Thus Soemmering describes four and Todd nine, while Cruveilhier doubts the presence of more than one. The four mentioned by Soemmering are the tensor of the tympanum, the greater and lesser laxator of the tympanum, and the stapedius. Of these, the tensor of the tympanum is the only one about the existence of which there is no dispute.

Fig. 265.



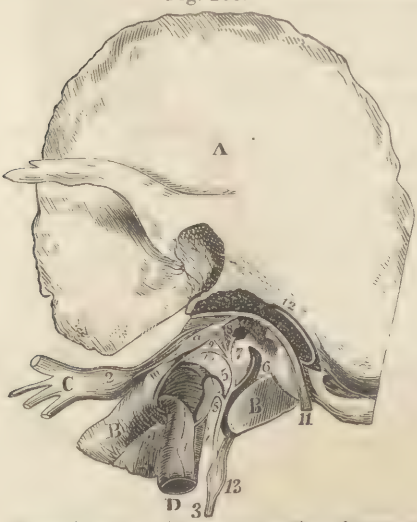
Ossicles of ear in their natural juxtaposition, magnified three diameters. 1, handle of malleus; 2, head of malleus; 3, body of incus; 4, short process, 5, long process of incus; 6, orbicular bone; 7, stapes; 8, long process of malleus.

In regard to the other muscles said to be connected with the ossicles of the ear, the author is inclined to doubt their existence, simply for the reason that there seems to be no use for them, the tensor of the tympanum being able to accomplish all that is necessary in regulating the tension of the bony chain to varying conditions of the membrane, as will be presently stated.

The **Tensor of the Tympanum** (*tensor tympani*) consists of a small, tapering, fleshy belly, which arises from the cartilaginous part of the Eustachian tube near where it joins the bone, and from the adjacent margins of the bony canal lying immediately above and parallel with the bony part of the tube; it passes horizontally backward through that canal to the forepart of the tympanum, and there ends in a delicate tendon which turns over a pulleylike surface upon the cochleariform process, and passes outward to be inserted into the forepart of the handle of the malleus near its root.

Use.—To draw the handle of the malleus inward and its head outward; the incus, from its firm connection with the head of the malleus, follows that bone, and, as it swings upon its short horizontal process, its vertical process is carried inward, and therefore presses the stapes against the oval opening, or, in other words, renders the chain of bones stiff and unyielding. The function of this muscle is therefore analogous to that of the iris, which regulates the admission of light to the retina. Thus when the sonorous vibrations are slight the muscle contracts, and renders the chain of bones almost as rigid and unyielding as though it consisted of a single piece, so that even the feeblest pulsations are transmitted without loss to the internal ear. On the other hand, when the vibrations are violent and sudden the muscle relaxes, and the bony chain being thus allowed to bend at the two articulations, the force of the impresssion is broken, and, in a measure, dissipated, before it reaches the sentient membrane.

Fig. 266.



Tympanic nerve. A, squamous portion of temporal bone; B, petrous portion; C, inferior maxillary nerve; D, internal carotid artery; *a*, tensor tympani muscle. 1, carotid plexus; 2, otic ganglion; 3, glosso-pharyngeal nerve; 4, tympanic nerve; 5, branches to carotid plexus; 6, branch to round opening; 7, branch to oval opening; 8, branch to join large superficial petrosal nerve; 9, small superficial petrosal nerve; 10, nerve to tensor tympani muscle; 11, facial nerve; 12, chorda tympani; 13, petrous ganglion of glosso-pharyngeal; 14, branch to membrane lining Eustachian tube.

Vessels and Nerves of the Tympanum.—The *arteries* of the tympanum are minute branches of the internal maxillary, internal carotid, and posterior auricular. The *veins* follow the course of the arteries, and terminate in the middle meningeal and pharyngeal veins. The *nerves* of the tympanum are derived from the tympanic plexus, which is situated upon

the promontory of the tympanum, and formed by communications between Jacobson's nerve, a filament from the carotid plexus, a branch which joins the great superficial petrosal nerve, and, lastly, the small superficial petrosal nerve from the otic ganglion. The arrangement of these nerves may be seen in Fig. 266.

THE INTERNAL EAR OR LABYRINTH.

The Internal Ear, the sentient division of the organ of hearing, is situated in the substance of the petrous bone, between the tympanum and the internal auditory meatus. It consists of a tortuous passage, called the bony labyrinth, in which is contained the expansion of the auditory nerve, supported by a fibro-vascular membrane, called the membranous labyrinth.

The Bony or Osseous Labyrinth is divided into three parts, named respectively the vestibule, semicircular canals, and cochlea. The three divisions of the labyrinth are lined by a continuous fibro-serous membrane, whose outer aspect is closely attached to the walls of the cavity. Its entire surface is smooth, and covered by a scaly epithelium, and secretes a thin serous fluid called the *perilymph* (liquor Cotunnii), which occupies the space between the bony and the membranous labyrinth. It is by the continuation of this membrane across the oval and round openings that the communication between the tympanum and labyrinth is entirely closed.

Fig. 267.

Bony labyrinth, largely magnified and divided longitudinally. 1, 1, 1, ampullated extremity of semicircular canal; 2, superior semicircular canal; 3, posterior semicircular canal; 4, inferior semicircular canal; 5, semi-elliptic fossa; 6, hemispheric fossa; 7, vestibule; 8, aqueduct of vestibule; 9, aqueduct of cochlea; 10, scala tympani, below spiral lamina; 11, osseous zone of spiral lamina, above which is scala vestibuli communicating with vestibule; 12, cochlea.

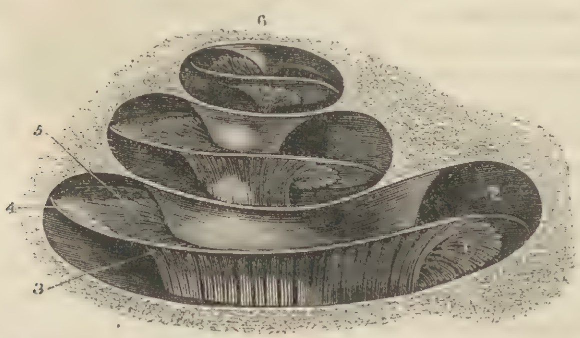
The **Vestibule**, the dilated central chamber or body of the labyrinth, is about the size of a grain of wheat, compressed laterally, and placed midway and vertically between the semicircular canals behind and the cochlea

in front. Its outer wall forms the internal wall of the tympanum, and presents the oval opening (fenestra ovalis) to which the base of the stapes is attached. The inner or posterior wall is perforated by numerous small foramina, for the entrance of the branches of the auditory nerve. Upon the same part is the orifice of a small canal, called the *aqueduct of the vestibule*, which terminates upon the posterior surface of the petrous bone, and transmits a venous twig. The anterior extremity leads to the mouth or entrance of the cochlea; the posterior is perforated by five round openings communicating with the semicircular canals.

The **Semicircular Canals** are three bony tubes, of different sizes, bent as represented in the preceding figure, and communicating, as before mentioned, with the upper back part of the vestibule. The superior one is nearly vertical, and forms a small elevation on the upper surface of the petrous portion of the temporal bone. Near the mouth of each one will be observed a slight dilatation called the *ampulla.*

The **Cochlea** is a bony canal, about an inch and a half long and little more than a line in diameter, coiled upon itself three times, so as to form a blunt cone, whose base presents toward the internal auditory meatus. Its external surface is marked by a spiral groove corresponding to the septum, which separates the coils of the canal, and gives to it the appearance of a snail's shell, from which circumstance its name is derived.

Fig. 268.



Magnified view of cochlea of new-born infant, opened on side toward apex of petrous portion of temporal bone. 1, scala tympani; 2, scala vestibuli; 3, spiral lamina; 4, zone of Valsalva; 5, osseous zone; 6, cupola.

The central pillar, called the *modiolus*, around which the cochlea is wound, is soft and spongy, and traversed by numerous canals which transmit branches of the auditory nerve. Its outer surface is marked by a spiral ridge or crest of compact bony tissue, called the *spiral lamina*, which projects into the canal and divides it partially into two half canals, called the *scalæ.* In the recent state, this division is completed by a

membranous septum, called the *zone of Valsalva*, nearly as far as the blind extremity or *cupola* of the canal, where the two communicate with each other. One of the scalæ, the *scala tympani*, communicates with the tympanum by the round opening, which, however, is closed in the recent state by a fibrous membrane called the secondary membrane of the tympanum. Near this opening is the orifice of a minute canal named the *aqueduct of the cochlea*, which terminates at the jugular fossa and transmits a small vein. The *scala vestibuli*, the superior of the two, communicates with the vestibule by a large orifice.

The **Membranous Labyrinth** is a delicate membranous sac contained within the bony labyrinth, which it exactly resembles in form, but is smaller, and separated from the surrounding walls by the perilymph. The vestibular portion of the sac is divided into two unequal parts, of which the larger is named the utricle and the smaller the saccule. The *utricle* or common sinus is situated in the upper back part of the vestibule, and communicates by five large orifices with the membranous semicircular canals, receiving upon its outer wall the branches of the auditory nerve that traverse the foramina in the bone in this situation. The *saccule* has a more globular form, is situated in the lower and anterior part of the vestibule, near the mouth of the vestibular scala, and, although in contact with the utricle, is said to have no communication with it.

Fig. 269.

Membranous labyrinth with its vestibule, semicircular canals, and nerves. 1, superior semicircular canal; 2, external semicircular canal; 3, inferior semicircular canal; 4, union of superior and inferior canals; 5, utricle; 6, saccule; 7, facial nerve; 8, anterior fasciculus of auditory nerve; 9, nerve of saccule; 10, 10, nervous fasciculi of superior and external ampullæ; 11, nerve of utricle; 12, posterior fasciculus of auditory nerve, furnishing 13, filaments to saccule, and 14, filaments to cochlea.

The semicircular portion of the membranous labyrinth conforms precisely to the bony semicircular canals, from which it is separated by a small quantity of perilymph. It communicates by five orifices with the cavity of the utricle, and opposite each ampulla receives branches of the auditory nerve. The vestibular and semicircular portions are filled with a thin, limpid fluid, called the *endolymph*, floating in which, upon

each side of the delicate septum that separates the utricle and saccule, is a little rounded calcareous body called an *otolith.*

Structure of the Internal Ear.—The walls of the common sinus, saccule, and membranous semicircular canals present many points of resemblance. The membrane of which they are formed is generally thin and semitransparent, but it is thicker and more opaque where nerves and vessels enter. On the outer surface is a layer of minutely ramified bloodvessels and loose areolar tissue, which sometimes contains irregular deposits of pigment cells. Next to this vascular network, branches of the auditory nerve are distributed in the form of a distinct layer, within which is a fine areolar tissue, with, according to Huschke, a film of closely-set nucleated epithelial cells. It is doubtful how far the nervous layer extends in the semicircular canals beyond the ampullæ.

The membranous structure of the cochlea is not arranged in the form of a sac, as in the vestibule and semicircular canals, but consists of two layers resting on the opposite surfaces of the spiral lamina, and continuous with each other at the cupola. The cavities of the two scalæ are otherwise entirely filled with perilymph.

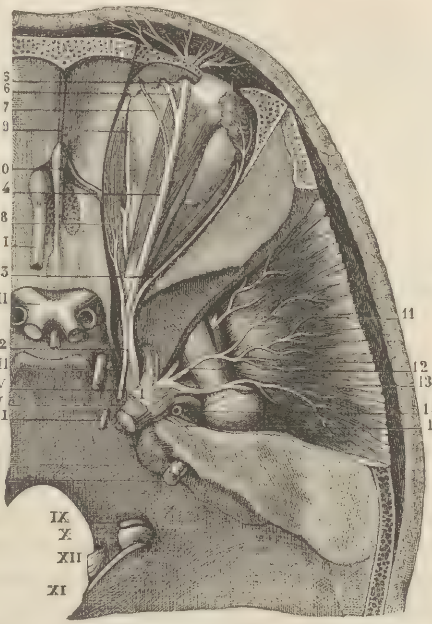
Vessels and Nerves of the Internal Ear.—The special *artery* of the internal ear is a small branch of the basilar, called the *internal auditory*, which enters the internal auditory meatus in company with the auditory and facial nerves, and, having reached the bottom of the canal, divides into vestibular and cochlear branches. Its ultimate ramifications are spent upon the membranous labyrinth.

The *Auditory Nerve*, the only nerve distributed to the internal ear, enters the internal auditory meatus together with the internal auditory artery and facial nerve, and, at the bottom of that canal, the nervous filaments become freed of their common fibrous sheath, and pass through the foramina in the cribriform plate of bone that bounds the bony labyrinth in this situation. Having entered the bony labyrinth, the filaments become collected into six bundles, which are distributed respectively to the several parts of the membranous labyrinth, namely, to the utricle, saccule, cochlear membrane, and semicircular canals.

OUTLINE OF THE DISTRIBUTION OF THE FIFTH OR TRIFACIAL NERVE.

THE Fifth or Trifacial Nerve arises apparently, as heretofore seen, from the lateral surface of the Varolian bridge, where it presents itself in the form of two unequal roots, which may be traced respectively to the restiform and anterior pyramidal bodies of the medulla oblongata. From the point where they perforate the bridge they proceed forward side by side to the upper surface of the apex of the petrous bone, where the larger or sensory root enters the ganglion of Gasser. The smaller or motor root passes beneath the ganglion, having no communication with it, leaves the cranial cavity at the oval opening in the sphenoid bone, and forms with one of the branches of the ganglion the inferior maxillary nerve.

Fig. 270.



Trifacial nerve, with upper part of orbit and temporal fossa removed. 1, semilunar ganglion; 2, ophthalmic nerve; 3, lachrymal nerve; 4, frontal nerve; 5, 6, its two principal branches; 7, branch passing from orbit above pulley of superior oblique muscle; 8, nasal nerve; 9, its external nasal branch; 10, course of internal nasal nerve from orbit into cranium and nose; 11, 12, 13, temporal branches of inferior maxillary nerve; 14, commencement of auriculo-temporal nerve; 15, greater petrosal nerve. I, olfactory nerve; II, optic nerves; III, motor ocular nerve; IV, pathetic nerve to superior oblique muscle of eye; V, trifacial nerve, its small root visible beneath cut end of large root, which forms semilunar ganglion, dividing into ophthalmic, superior and inferior maxillary nerves; VI, abducent nerve; VII, facial, included in groove of auditory nerve, VIII, both entering auditory meatus; IX, glosso-pharyngeal, X, pneumogastric, and XI, spinal accessory nerves emerging at jugular foramen; XII, hypoglossal nerve.

The **Ganglion of Gasser,** the largest nervous ganglion in the body except the semilunar ganglion of the sympathetic system, is situated upon the upper and anterior aspect of the extremity of the petrous portion of the temporal bone, and beneath the dura mater, which, on account of its close attachment, requires to be dissected off with great care. It is flattened from above downward,

crescentic in shape, its concavity presenting upward and backward, and of a grayish-white color. It receives upon its concavity the divergent fibres of the sensory root of the nerve, and one or two small filaments from the carotid plexus of the sympathetic, and from its convexity are given off three large trunks, known as the first, second, and third branches of the fifth pair, or, more commonly, as the ophthalmic, superior maxillary, and inferior maxillary branches. The last is joined by the motor root, and the two together constitute the inferior maxillary nerve.

THE OPHTHALMIC NERVE.

The Ophthalmic Nerve, the smallest of the primary divisions of the trifacial, passes forward through the outer wall of the cavernous sinus, where it receives communicating filaments from the sympathetic, and then divides into three branches, the lachrymal, frontal, and nasal, which enter the orbit at the sphenoidal foramen.

The **Lachrymal Nerve**, the smallest of the three, passes forward along the outer wall of the orbit, and is distributed to the lachrymal gland and the adjacent part of the upper eyelid and conjunctiva.

The **Frontal Nerve**, being much larger than the others, may be considered as the continuation of the main trunk. It runs forward between the elevator muscle of the eyelid and the roof of the orbit, traverses the supraorbital notch, where it takes the name of the *supraorbital nerve*, and is distributed to the skin of the forehead and anterior part of the scalp. Within the orbit it sends off a branch called the *supratrochlear* (Fig. 261), which passes over the border of the orbit internally to the notch, and supplies the skin of the upper eyelid and root of the nose.

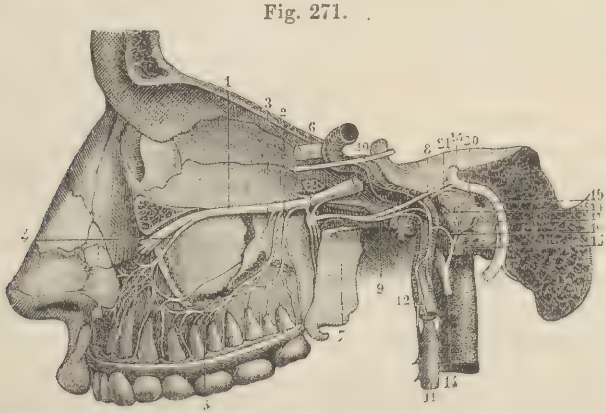
The **Nasal Nerve** enters the orbit at the sphenoidal opening between the two heads of the external straight muscle, passes forward and inward along the roof of the cavity as far as the anterior internal orbital foramen, through which it re-enters the cavity of the cranium; it then crosses the cerebral surface of the cribriform plate of the ethmoid bone, traverses a small foramen by the side of the ethmoidal crest, and is distributed to the lining membrane of the nose, one or more filaments reaching as far as the skin at the margin of the nostril. While within the orbit, it furnishes an offset to the lenticular ganglion, several to the eyeball, called the *ciliary nerves*, and one, called the *infratrochlear*, which continues forward, gives branches to the lachrymal sac and caruncle, and, emerging from the orbit, is expended upon the skin of the eyelid and side of the nose.

The **Ophthalmic** or **Lenticular Ganglion**, generally considered as belonging to the fifth nerve, is not larger than a pin's head, and situated in the back part of the orbit, and upon the outer aspect of the optic nerve, where it is imbedded in areolar adipose tissue. It receives a filament from the nasal branch of the ophthalmic, one from the motor ocular nerve, and one from the carotid plexus of the sympathetic. Furnished thus with motor, sensory, and sympathetic fibres, it gives off ten or twelve branches (*ciliary nerves*), which pass forward, perforate the sclerotic coat of the eye, and are distributed to the iris.

THE SUPERIOR MAXILLARY NERVE.

The Superior Maxillary Nerve, the second division of the fifth pair, arises from the middle of the anterior border of the Gasserian ganglion, passes horizontally forward through the round opening (foramen rotundum) of the sphenoid bone, crosses the spheno-maxillary fossa to reach the groove upon the back part of the floor of the orbit, traverses the infraorbital canal, and, emerging at the infraorbital foramen upon the anterior surface of the superior maxillary bone, divides into a lash of filaments which are distributed to the skin of the eyelid, cheek, and upper lip.

Fig. 271.



Superior maxillary nerve, with external wall of left orbit and of superior maxillary bone removed. 1, superior maxillary nerve in its course through infraorbital canal; 2, 3, posterior dental nerves; 4, anterior dental nerve; 5, anastomosis between dental nerves; 6, spheno-palatine ganglion (branch from superior maxillary nerve above is commencement of temporo-malar nerve); 7, pterygoid nerve; 8, greater petrosal nerve joining facial nerve; 9, deep petrous nerve joining carotid plexus of sympathetic; 10, abducent nerve with its communicating branches of latter plexus; 11, superior cervical ganglion; 12, ascending branches to carotid plexus; 13, facial nerve; 14, glosso-pharyngeal nerve; 15, tympanic nerve; 16, branch to carotid plexus; 17, 18, 19, branches to round and oval openings and Eustachian tube; 20, branch to small petrosal nerve, 21.

Before entering the infraorbital canal the superior maxillary nerve gives off the orbital, spheno-palatine and posterior dental branches, and, while in the canal, the anterior dental branch.

The **Orbital Nerve** enters the orbit through the spheno-maxillary fissure, and divides into a temporal and a malar branch; the former proceeds forward along the outer wall of the orbit, near the anterior margin of which it enters a foramen in the malar bone, and is distributed to the skin of the temple; the latter runs to the lower outer margin of the orbit, also traverses a foramen in the malar bone, and is distributed to the skin of the cheek.

The **Spheno-palatine Nerves,** two in number, descend to join the spheno-palatine or Meckel's ganglion.

The **Posterior Dental Nerves,** two in number, descend upon the tuberosity of the superior maxillary bone, which they perforate, and are distributed to the three molar teeth of the upper jaw and the contiguous gums.

The **Anterior Dental Nerve** descends along a small groove or canal on the posterior surface of the anterior wall of the antrum, and divides into several branches which supply the canine and incisor teeth.

The **Infraorbital Nerve,** the continuation of the main trunk of the superior maxillary nerve, leaves the infraorbital canal at the infraorbital foramen, and breaks up immediately into numerous branches, which diverge and are distributed respectively to the skin of the lower eyelid and side of the nose, and to the skin and mucous membrane of the upper lip.

The **Spheno-palatine** or **Meckel's Ganglion** (Fig. 271, $_6$) is connected with the spheno-palatine branches of the superior maxillary nerve. It is situated in the pterygo-maxillary fossa, immediately in front of the root of the pterygoid process, and very near the spheno-palatine foramen. It is small and triangular, and gives off numerous branches, which descend to be distributed to the mucous membrane of the hard and soft palate, uvula, gums, tonsils, and lining membrane of the nose.

The **Vidian** or **Pterygoid Nerve,** considered as an offset from the spheno-palatine ganglion,* leaves it behind, passes through the Vidian or pterygoid canal, and divides into two principal branches. One of these divisions, called the *superficial petrosal nerve*, enters the cranium through the sphenoidal fissure, passes along the outer side of the internal carotid artery and beneath the Gasserian ganglion, and enters the groove leading to the Fallopian hiatus, through which it reaches the ganglion of the facial nerve. The other branch, called the *carotid*, joins the sympa-

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* Many anatomists describe the Vidian as a branch of the facial to Meckel's ganglion, and it is not unlikely that they are correct.

thetic nerve upon the surface of the carotid artery. Besides these, the Vidian also sends filaments to the lining membrane of the back part of the roof of the nose, the nasal septum, and Eustachian tube.

THE INFERIOR MAXILLARY NERVE.

The Inferior Maxillary Nerve, the third and largest division of the fifth, unlike the two others, consists of both a motor and sensory trunk, the former being the continuation of the motor root heretofore mentioned, and the latter one of the offsets from the ganglion of Gasser. The two portions enter the oval foramen of the sphenoid bone, and then unite to form a common trunk, which, a short distance below the base of the skull, divides into two main branches, known as the superior or small, and the inferior or large division.

The *superior division* contains nearly all the motor fibres, and furnishes the following branches: 1, *deep temporal* branches, two in number, distributed to the temporal muscle; 2, the *masseteric* branch; 3, the *buccal* branch; and 4, the two *pterygoid* branches, distributed respectively to the masseter, buccinator, and the two pterygoid muscles.

The *inferior division*, larger than the superior, is composed almost entirely of sensory fibres; it sends a filament to the otic ganglion, and subdivides into the auriculo-temporal, gustatory, and inferior dental nerves.

The **Auriculo-temporal Nerve** turns off from the main trunk by two roots, which inclose the middle meningeal artery just before it enters the skull, passes backward beneath the external pterygoid muscle and close upon the inner side of the articulation of the lower jaw, then ascends beneath the parotid gland and over the root of the zygoma to join the superficial temporal artery, with which it is distributed. It gives branches to the lining membrane of the external auditory meatus, to the skin upon the temple and side of the head, and communicating filaments to the facial nerve.

The **Gustatory** or **Lingual Nerve*** is directed downward and forward beneath the external pterygoid muscle, and between the internal pterygoid and ramus of the lower jaw, to the side of the tongue, along which it is continued beneath the mucous membrane as far as the tip. It is joined near its origin by the tympanic branch of the facial, which emerges from the glenoid fissure, and finally reaches the submaxillary ganglion.

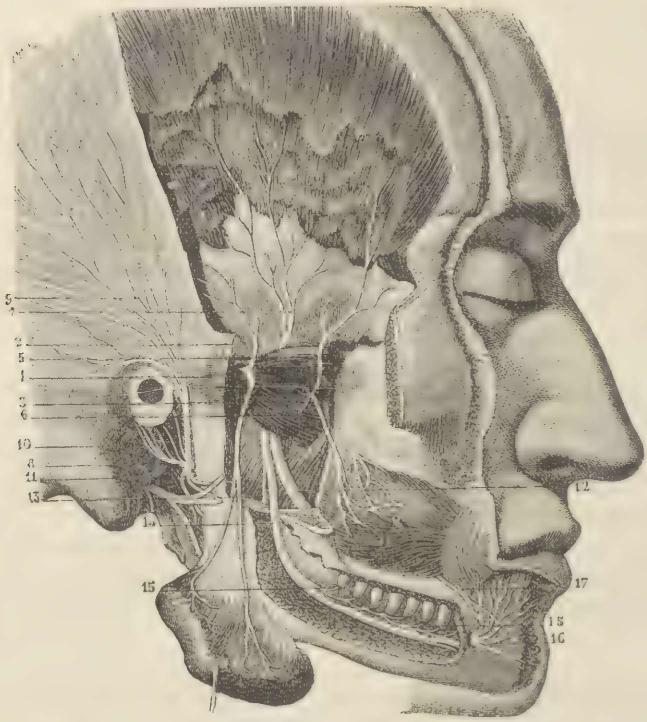
The gustatory nerve sends a few small twigs to the mucous membrane

* The term Lingual Nerve is generally applied to the Hypoglossal, while the one here referred to is more accurately described as the Gustatory or Lingual *branch* of the fifth pair.

of the floor of the mouth, submaxillary ganglion and sublingual gland; but the great bulk of the fibres perforate the tongue from below upward and terminate in the papillæ of taste.

The **Inferior Dental Nerve** descends from its origin in company with the gustatory, which it soon leaves, however, to enter the dental canal upon the inner face of the ramus of the lower jaw. Within the canal it runs forward in company with the dental artery, sending branches to the respective teeth, and terminating in a lash of fibres, which emerge at the mental foramen and are distributed to the skin of the lower lip and chin.

Fig. 272.



Distribution of inferior maxillary nerve. 1, muscular branch to masseter muscle; 2, 5, 7, branches to temporal muscle; 3, branch to buccinator, anastomosing with one from facial at 4; 6, external pterygoid muscle; 8, auriculo-temporal nerve, with its branches, 9, to temple, 10, to ear, and anastomosing, at 11, with facial; 12, lingual branch of fifth; 13, branch to mylo-hyoid muscle from inferior dental nerve, 14; 15, branches to teeth; 16, terminal branches to lower lip and chin.

Before entering the dental canal, the dental nerve gives off the *mylo-hyoid* branch, which passes forward along the groove upon the inner surface of the lower jaw, and is distributed to the mylo-hyoid muscle and anterior belly of the digastric. It is composed exclusively of the few motor fibres which accompany the lower division of the main trunk of the inferior maxillary nerve.

The **Otic Ganglion**, alluded to in the preceding description of the inferior maxillary nerve, is situated upon the inner side of the main trunk, just below the oval opening in the sphenoid bone, but owing to its very small size is often very difficult to find. It receives filaments from the sensory division of the inferior maxillary, and one or more from the sympathetic branches which accompany the middle meningeal artery, and one from the auriculo-temporal nerve. It communicates with the facial nerve by means of the *small petrosal nerve*, which passes backward, enters the cranium through a minute opening in the spinous process of the sphenoid bone, traverses a groove upon the anterior inferior border of the petrous bone, and divides into two filaments, one of which joins the facial nerve in the aqueduct of Fallopius, and the other the tympanic branch of the glosso-pharyngeal. From the ganglion are also given off filaments to the tensor muscle of the tympanum and the circumflex muscle of the palate.

The **Submaxillary Ganglion**, also very small, is situated just below the main trunk of the gustatory nerve, and behind the duct of the submaxillary gland. It receives a motor filament, called the *tympanic branch* (chorda tympani), from the facial, sensory filaments from the gustatory, and sympathetic branches from the plexus which surrounds the facial artery. It sends branches principally to the submaxillary gland, and a few to the sublingual.

ANATOMICAL PECULIARITIES OF THE FŒTUS.

A DESCRIPTION of the Anatomical Peculiarities of the Fœtus is designed to include only such points in its construction as absolutely distinguish it from the adult, and not the intricate history of its various stages of development. The latter would involve a discussion of the histology of fœtal existence beyond the scope of an elementary work. The general rules laid down in the earlier portions of this volume for the dissection of the fully-developed child or adult apply as well to the fœtus, and to these must be added a strict regard to delicate manipulation of the fragile undeveloped structures.

The peculiarities of the fœtus may be studied regionally, following, for this purpose, the plan adopted in the dissection of the adult; the Abdomen, Pelvis, Thorax, etc. being investigated consecutively.

The Abdomen.—The chief peculiarities of the Abdominal Region are those connected with the fœtal circulation; the enormous development of the liver; and slight variations in the structure and contents of the intestinal canal.

The *Abdominal Circulation* of the fœtus will be appropriately described as an intimate part and continuation of the vascular distribution of the thoracic region (see p. 638).

The *Liver* is proportionately larger at this time than the other organs of the body, occupies both hypochondriac regions, is about equally developed on the two sides of the abdomen, and is much darker in appearance than after birth. It probably supplies, during fœtal life, the functions afterward filled by the lungs in getting rid of carbon from the system; and, as a smaller quantity of blood would be sent to the liver after the functions of the lungs were once established, the rapid decrease in the bulk of that organ after birth may, perhaps, be accounted for.

The *Intestines* of the fœtus are smaller in proportion than in after-life, and contain a quantity of greenish-black fæces, called the meconium.

The Pelvis and Organs of Generation.—The peculiarities of the Pelvis and Generative Organs of the fœtus are those of the circulatory apparatus, the modified development of the urinary bladder, and the formation and descent of the testicles in the male, and of the ovaries in the female.

The *Circulation in the Pelvic Cavity* will be referred to as part of the general sketch of the Fœtal Circulation (see p. 638).

The *Urinary Bladder* is proportionately longer than in the adult, reaching almost as high as the umbilicus, to which it is attached by a conical fibrous ligament, called the *urachus*, which there becomes confounded with the aponeurosis of the abdomen. The muscular coat of the fœtal bladder possesses more irritability than in adult life.

The *Testes* and *Ovaries* are, during earlier fœtal life, abdominal organs, but afterward descend into the pelvis, the former about the sixth month. The passage of these organs downward from the lumbar region has already been described (see, for Descent of the Testes, p. 235; for Descent of the Ovaries, p. 341).

The **Inferior Extremities** of the fœtus present but few points of interest. Their development is much less marked than that of the upper regions of the body, a smaller quantity of blood, through the descending aorta, being supplied for their nutrition; but no marked peculiarities of the circulatory apparatus exist worthy of description.

The **Superior Extremities** of the fœtus present no special points of interest to the dissector.

The **Head** and **Neck** may be referred to conjointly, as in the anatomy of the adult.

The Head is large, the cranial bones are united by means of interposed membrane, and the sutures of the skull are numerous, the frontal bone, for example, being divided into two segments by the continuation of the sagittal suture downward to the nose. Spaces, called *Fontanelles*, also exist at the junction of various bones; the *anterior fontanelle* being a quadrangular interval between the coronal and sagittal sutures, closed by membrane; the *posterior fontanelle* being a triangular space, similarly formed, where the posterior and superior angles of the parietal bones unite with the upper part of the occipital bone. The *Interior of the Skull* presents no remarkable anatomical peculiarities worthy of dissection, though the development of the encephalic hemispheres and associate parts are especially interesting as matters of General Anatomy.

The Neck contains the *Thyroid Body* or *Gland*, much larger, proportionately, than in after-life, an organ whose functions are not known (see p. 474). No other peculiarities are found here for separate description.

The *Circulation of the Head and Neck* need not be referred to, apart from the general circulation (see p. 638).

The *Eye* of the fœtus, during early periods of its existence, is closed by a vascular membrane, called the *membrana pupillaris*, covering the pupil, and taking its origin from the inner margin of the iris. This

membrane is absorbed, and disappears about the seventh month. The *lens* is softer, less transparent, and more spherical than after birth.

The Thorax and Back.—This region is far the richest in fœtal peculiarities, most of the features of interest distinguishing the intra-uterine from the extra-uterine condition being revealed by this dissection. The fœtal circulation does not, strictly speaking, take its origin here, and cannot, therefore, as in the adult, be described as passing from the heart as a centre, but is conveniently traced from its placental extremity. The heart, with its peculiar construction of valves and vessels, the undeveloped lungs, and the thymus body or gland, are the organs specially deserving of notice, which are found in the dissection of the cavity embraced within the walls of the Thorax and Back.

The *Thymus Body* has already been referred to in the dissection of the Anterior Mediastinum of the adult (see p. 512).

The *Lungs* are dense and dark, not unlike the liver in color, and do not fill the whole of the cavity of the chest. When air has passed into them, as at birth, they become pinkish, and compressible, and occupy the whole cavity of the pleura.

The *Heart* is divided, as in the adult, into auricles and ventricles, but the distribution of the vessels and the relations of the cavities are peculiar. A communication exists between the two auricles, through an orifice called the *oval foramen* or *foramen of Botal.* The *Eustachian valve*, of large size, serves to direct the current of blood from the ascending cava vein directly through this opening. In the early stages of fœtal existence, the auricles are more developed than the ventricles, but towards birth the latter assume about the proportionate size to the former that they maintain in after-life. The oval foramen usually becomes closed a few days after birth.

In connection with the Anatomy of the Heart, the peculiarities of the Fœtal Circulation and its course may be briefly sketched.

Circulation of the Fœtus.—*The Arteries.*—The peculiarities in the Arterial System are the modes of communication between the descending aorta and the pulmonary artery, and between the internal iliacs and the placenta by means of the umbilical arteries.

The *pulmonary artery* does not divide into two branches, as in the adult, but into three, one of which, called the *ductus arteriosus*, opens into the descending aorta, the other two being distributed to the lungs. The ductus arteriosus is thus the channel through which the greater part of the blood of the right ventricle is carried into the descending aorta.

The *umbilical* or *hypogastric arteries* come off from the internal iliacs, mount along the side of the bladder externally to the peritoneum, and emerge from the abdomen at the umbilicus, to be distributed along the

umbilical cord to the placenta. The blood which has been inservient to the uses of the fœtus is thus returned to the placenta.

After birth the ductus arteriosus becomes an impervious ligamentous cord, the greater portion of each umbilical artery undergoing a similar transformation, and becoming the anterior true ligament of the bladder, the small portion not so affected giving origin to the superior vesical arteries.

The Veins.—The Venous System is also characteristic, a communication being formed between the placenta and the liver through the *umbilical vein*, which divides into branches, one of which, a canal called the *ductus venosus*, passes directly to the cava vein, thus transmitting a portion of the blood at once into the great venous system. The ductus venosus and the umbilical vein are also, after birth, converted into fibrous cords, the latter becoming the round ligament of the liver.

Course of the General Circulation.—The prominent peculiarities of the circulation in the fœtus having thus been stated, the general vascular distribution may be briefly described; commencing, for convenience, with the placenta, in contact with which the blood has undergone a process of change similar to the more perfect conversion it derives in extra-uterine life from its passage through the lungs.

The blood, proceeding from the placenta, passes to the fœtus through the umbilical vein to the liver, where a portion of it is poured into the portal vein, a second portion into the ascending cava through the hepatic veins, and still another supply, as before mentioned, into the ascending cava directly through the ductus venosus, so that all the blood from the umbilical vein passes, sooner or later, into the cava vein, and thence into the right auricle of the heart; whence, guided by the Eustachian valve, the main current passes directly into the left auricle through the oval foramen, while a small portion is carried into the right ventricle.

From the right ventricle it is transmitted through the pulmonary artery to the lungs, but, only being needed there for purposes of nutrition and not of respiration, the greater part passes through the ductus arteriosus, as already mentioned, directly into the aorta, along which it descends, partly to be distributed to the abdominal and pelvic viscera and the inferior extremities, but mainly through the umbilical arteries to the placenta. The blood sent to the left auricle through the oval foramen, as well as that portion brought back from the lungs to the left auricle, is transmitted to the left ventricle, and thence to the aorta, by means of which vessel it is conveyed to the head and superior extremities, to be returned to the right side of the heart through the descending cava.

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THE END.